STUDIES ON THE EXPIRATORY INCOMPETENCY IN PULMONARY EMPHYSEMA

PRESENTATION OF THE CLINICO-PHYSIOLOGICAL ASPECTS OF THE SENILE PULMONARY EMPHYSEMA

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(Received on July 10, 1958)

INTRODUCTION

The pathogenesis of pulmonary emphysema has been suggested the existence of pulmonary emphysema of non-obstructive type which is different from the chronic pulmonary emphysema of obstructive type. It has also been experienced such cases with pulmonary emphysema clinically which shows somewhat different signs and symptoms with the characteristic chronic pulmonary emphysema. The author has studied the impaired pulmonary functions in cases with senile pulmonary emphysema with special reference to their expiratory incompetency.

MATERIAL AND METHODS

The results of pulmonary function tests performed on 365 cases with pulmonary emphysema and 113 cases with bronchial asthma are presented in this paper. There is a health examination program to make detailed medical checkups which are carried out during one-week hospitalization in Keio University Hospital. 129 cases out of those referring emphysematous patients had been found in such pulmonary function tests performed for the purpose of the medical examination and others had been found in the ambulatory patients or inpatients with suspected pulmonary emphysema who had visited Keio University Hospital because of their complaints of dyspnea.

The pulmonary function tests were carried out on the ventilatory- and the alveolar functions.

The ventilatory functions are discussed on the fractions of lung volumes, and other ventilatory characteristics. The ventilatory functions were tested by the spirographic method using the 9L-Benedict-Roth respirometer and the O₂ dilution method with modified Cournand-Richards' open circuit system. The types of impairment in the ventilatory functions are classified as following

with special reference to the vital capacity and the timed vital capacity.

A. The normal ventilatory function: Two-stage vital capacity is found more than 80% of the predicted and the timed vital capacity in the 1st second is more than 70% of the one-stage vital capacity.

B. The restrictive ventilatory impairment: Two-stage vital capacity is decreased less than 80% of the predicted values and the timed vital capacity in the 1st second is maintained more than 70% of the one-stage vital capacity.

C. The combined ventilatory impairment: Two-stage vital capacity is decreased less than 80% of the predicted ones and the timed vital capacity in the 1st second is also decreased less than 70% of the one-stage vital capacity.

D. The expiratory incompetency: Two-stage vital capacity is maintained more than 80% of the predicted ones whereas the timed vital capacity in the 1st second is decreased below 70% of the one-stage vital capacity.

The alveolar functions are discussed on the intrapulmonary distribution of inspired gas with special reference to the gas distribution curve, the oximeter rate and the relationship between both the gas distribution curve and the oximeter rate. Breathing pure O₂ with the open circuit system to measure the functional residual capacity every endtidal N₂ concentrations were followed up along the time course with the nitrogen meter and simultaneously the oximeter rate was obtained by measuring the arterial O₂ saturation with earpiece oximeter.

DEFINITION AND PHYSIOLOGICAL ASPECTS OF THE OBSTRUCTIVE IMPAIRMENT

To illustrate the obstructive ventilatory impairment the author will at first refer to the pulmonary functions in every 20 typical cases with chronic pulmonary emphysema and with manifested bronchial asthma.

In those cases decreased maximum breathing capacity and timed vital capacity were quite significant. In addition to those referring two important ventilatory factors, the degree of air trapping should be taken into consideration to characterize the obstructive ventilatory impairment. The air trapping has been evaluated through various method of expression, such as the difference between expiratory and inspiratory vital capacity, the elevation in respiratory midposition during voluntary ventilatory effort, or increase in residual volume during repeated maximum expiration.

In some cases with pulmonary emphysema and with bronchial asthma the significant difference between one-stage vital capacity and two-stage vital capacity had been found. The author had introduced the index of air trapping

from the referring difference in one- and two-stage vital capacity, which well corresponds with the Leslie's index.

$$\text{INDEX OF AIR TRAPPING} = \frac{\text{two-stage VC} - \text{one-stage VC}}{\text{two-stage VC}} \times 100 (\%)$$

The normal allowance of the index of air trapping is considered to be 0–5%. In cases of chronic pulmonary emphysema and of manifested bronchial asthma the index of air trapping had shown remarkable increase (Fig. 1).

Fig. 1 Index of air trapping in various pulmonary diseases.

There are some cases which shows decreased maximum breathing capacity and timed vital capacity with increased index of air trapping. Those referring typical cases are considered to accompany significant obstructive ventilatory impairment. But there are some emphysematous cases with decreased maximum breathing capacity and timed vital capacity without accompanying any significant increase in the index of air trapping. Those cases are considered not to accompany the obstructive ventilatory impairment in the strict meaning. Theoretically there are any possibilities to show such ventilatory involvement if the loss of elasticity in the lung tissues, advanced thoracic deformity or the weakness of the respiratory muscles should be existed.

The author defined such ventilatory impairment, which is characterized by the decreased maximum breathing capacity and timed vital capacity, as the expiratory incompetency. If the cases with expiratory incompetency are accompanied by the significantly increased index of air trapping, the "obstructive ventilatory impairment," or the "obstructive expiratory incompetency" is con-

sidered to be established. If the cases with expiratory incompetency are not accompanied by any significantly increased index of air trapping the "non-obstructive expiratory incompetency" is defined. Further characteristic findings which represent the obstructive impairment is increase in ΔN_2 . It has been reported that in cases with obstructive impairment the index of intrapulmonary

Fig. 2 Terminal N_2 concentration and ΔN_2 in various pulmonary diseases.

Fig. 3 Index of air trapping and ΔN_2 .

Abscissa: Index of air trapping (%)

Vertical: ΔN_2 (%)

gas mixing has often been increased. The author, analyzing the gas distribution curve, had found that in most of the typical bronchial asthma and in chronic pulmonary emphysema ΔN_2 had shown large values significantly exceeding normal allowance. (Fig. 2 and 3).

To discuss the effect of the obstructive ventilatory impairment on the intrapulmonary distribution of inspired gas the gas distribution curves in 98 manifested young asthmatic patients had also been studied (Table 1). In

Table 1
Gas Distribution Characteristics in 98 Cases with Bronchial Asthma

	Range	Mean
FRC	1050-6120 cc	3460 $\pm$ 1150 cc
D. I. obs	0.28- 0.79	0.49 $\pm$ 0.15
D. I. calc	0.19- 1.30	0.68 $\pm$ 0.24
T. N ₂ -C.	0.2 - 6.8 %	1.4 $\pm$ 2.5 %
alv. Np	0.4 -17.6 %	5.6 $\pm$ 4.0 %
ΔN_2	0.1 -16.2 %	4.1 $\pm$ 3.3 %

FRC: Functional residual capacity (cc).
D. I. obs: Distribution index observed.
D. I. calc: Distribution index calculated.
T. N₂-C.: Terminal N₂ concentration (%).
alv. Np: Index of intrapulmonary gas mixing, N₂%.

the first portion of the gas distribution curve any significant exponential decrease in N₂ concentration could not be found. The transitory phase was quite significant and the decrease in endtidal N₂ concentration had still continued after 7 minutes inhalation of pure O₂ to show the higher value of the terminal N₂ concentration. It was characteristic to show large index of intrapulmonary gas mixing and ΔN_2 . Especially in cases with bronchial asthma remarkably large index of intrapulmonary gas mixing and ΔN_2 were observed as compared with the value of terminal N₂ concentration. Relatively smaller ΔN_2 was found in cases with slightly elevated RV/TLC ratio and in cases with significantly elevated RV/TLC ratio variant values of ΔN_2 up to 16% were found. But remarkably increased ΔN_2 was only found in cases with abnormally elevated RV/TLC ratio. Reverse correlation between ΔN_2 and percent timed vital capacity in 1st second versus one-stage vital capacity had been found and large ΔN_2 were found in cases with significantly decreased timed vital capacity. Between maximum breathing capacity and ΔN_2 the reverse correlation had also been found.

The significance of the obstructive expiratory incompetency will also be given by the following experimental observations. Almost normal ventilatory

functions are maintained in the latent stadium of the bronchial asthma, in which any significant decrease in maximum breathing capacity, timed vital capacity, ventilation reserve, elevation in RV/TLC ratio, increase in index of air trapping were not found. Using the Vaponefrin nebulizer inhalation of the acetylcholine aerosol of 5000–10000 γ had been made in 5 cases with bronchial asthma of

Fig. 4 Gas distribution curve and oximeter rate in cases of latent bronchial asthma, before and after inhalation of acetylcholine aerosol.

Table 2
Distribution Characteristics in Bronchial Asthma Before and After Inhalation of Acetylcholine Aerosol

Cases	Stage	FRC	RV/TLC	Air Trapping	D. I. obs	D. I. calc	DT	T. N ₂ -C.	ALV. NP	Δ N ₂
	B	3300cc	34.5 %	+4%	0.42	0.71	6 min.	0.2 %	1.9 %	1.7 %
	A	5220	53.5	+30	0.42	0.86	over 7	2.3	7.1	4.8
	B	2120	37.1	0	0.38	0.82	6	0.5	2.3	1.8
	A	2950	60.0	+26	0.46	0.62	over 7	3.3	7.5	4.2
	B	2430	39.2	0	0.49	0.83	4	0.3	1.1	0.8
	A	2720	44.0	+16	0.61	0.73	5	0.1	5.7	5.6
	B	1620	37.1	+2	0.77	0.96	2.5	0.6	0.8	0.2
	A	1690	39.6	+18	0.47	0.91	over 7	1.9	7.3	5.4
	B	3290	42.3	+1	0.42	0.57	4.5	0.4	0.8	0.4
	A	3480	50.4	+22	0.39	0.74	over 7	1.2	4.2	3.0

Stage A: After inhalation, Stage B: Before inhalation, FRC: Functional residual capacity, Air trapping: Index of air trapping, D. I. obs: Distribution index (observed), D. I. calc: Distribution index (calculated), DT: Distribution time, T. N₂-C: Terminal N₂ concentration, Alv.Np: Index of intrapulmonary gas mixing, N₂%.

latent stadium to induce the asthmatic symptoms with obstructive expiratory incompetency (Table 2, Fig. 4).

Through inhalation of acetylcholine-aerosol the maximum breathing capacity and the ventilation reserve were decreased and the RV/TLC ratio was elevated. Decrease in the percent timed vital capacity versus one-stage vital capacity and increase in the index of air trapping had also been observed. Significant transitory phase in the gas distribution curve had been observed and increase in index of intrapulmonary gas mixing and ΔN_2 were quite significant after inhalation of the aerosol. The index of air trapping and ΔN_2 in latent bronchial asthma had shown normal values whereas those had revealed significantly abnormally large values after inhalation of acetylcholine aerosol.

In cases with chronic pulmonary emphysema somewhat positive correlation between index of air trapping and ΔN_2 had been revealed. 11 typical cases of chronic pulmonary emphysema and 6 cases of manifested bronchial asthma had been administered 30 mg prednisolone daily for 7 days. The pulmonary function tests were performed before and after administration to investigate the effect of prednisolone on the obstructive ventilatory impairment. The improvement of transitory phase in the gas distribution curve had been accompanied by the decrease in index of air trapping and ΔN_2 to illustrate the relaxation of the obstructive expiratory incompetency (Fig. 5).

Fig. 5 Index of air trapping and ΔN_2 , before and after administration of prednisolone.

- Before administration
- After administration

In addition to the results of the pulmonary function tests in young asthmatic patients and in cases with typical chronic pulmonary emphysema, the pulmonary functions before and after inhalation of acetylcholine-aerosol to induce the obstructive ventilatory impairment, and the pulmonary functions before and after administration of prednisolone on the typical chronic pulmonary emphysema to relax the obstructive expiratory incompetency had established the physiological aspects of the obstructive expiratory incompetency.

DEFINITION OF THE SENILE PULMONARY EMPHYSEMA

The author has defined the senile (non-obstructive) pulmonary emphysema as following from the clinico-physiological standpoint. The senile pulmonary emphysema is 1) found in the aged, 2) without any signs and symptoms of manifested bronchial asthma in the patient's history, 3) accompanying any significant thoracic deformity due to the senescent kyphosis. The pulmonary function tests may reveal 4) increase in the residual volume and the total lung capacity with significantly elevated RV/TLC ratio, 5) significant decrease in the maximum breathing capacity and in the percent timed vital capacity in the 1st second to show the expiratory incompetency, 6) without any significant increase in the index of air trapping, and 7) ΔN_2 in the gas distribution curve may remain within normal limit or may even show only slight increase in it.

VENTILATORY FUNCTIONS IN THE SENILE PULMONARY EMPHYSEMA

A. *Lung Volumes:*

Increased residual volume and total lung capacity with elevated RV/TLC ratio were characteristic both in the chronic pulmonary emphysema and in the senile pulmonary emphysema. Variant difference between one-stage and two-stage vital capacity had been revealed in cases with pulmonary emphysema, but in cases with typical chronic pulmonary emphysema the difference was quite significant.

In the chronic pulmonary emphysema decrease in one-stage vital capacity as compared with increase in residual volume was significant to show the elevation in RV/TLC ratio. In cases with senile pulmonary emphysema decrease in one-stage vital capacity was rather slight as compared with that in the chronic pulmonary emphysema. The elevation in RV/TLC ratio up to 75% in the senile pulmonary emphysema was also significant as well as in the chronic pulmonary emphysema. 51 cases had shown the RV/TLC ratio higher than

Table 3
*Pulmonary Functions in Senile Pulmonary Emphysema and in
 Chronic Pulmonary Emphysema*

	Senile pulm. emphysema	Chron. pulm. emphysema
Vital capacity (obs/pred)	83 $\pm$ 17 %	64 $\pm$ 23 %
RV/TLC ratio	51.2 $\pm$ 18.1 %	62.2 $\pm$ 24.4 %
MBC (obs/pred)	82 $\pm$ 16 %	32 $\pm$ 27 %
Timed vital capacity (lsec)	1320 $\pm$ 360 cc	980 $\pm$ 410 cc
TVC (lsec)/VC (obs)	47 $\pm$ 15 %	44 $\pm$ 19 %
Distribution index (obs)	0.52 $\pm$ 0.11	0.43 $\pm$ 0.13
Distribution index (calc)	0.64 $\pm$ 0.19	0.47 $\pm$ 0.13
Terminal N ₂ concentration	0.7 $\pm$ 0.8 %	1.5 $\pm$ 1.6 %
Emptying rate	1.6 $\pm$ 1.1 %	4.4 $\pm$ 3.8 %
ΔN_2	0.9 $\pm$ 0.3 %	2.9 $\pm$ 2.7 %
Art. O ₂ saturation	93.2 $\pm$ 9.6 %	91.1 $\pm$ 15.3 %
Saturation time	116 $\pm$ 42 sec	93 $\pm$ 21 sec
DIXST	0.98 $\pm$ 0.42	0.67 $\pm$ 0.39
Art. CO ₂ tension	44.5 $\pm$ 10.5 mmHg	49.2 $\pm$ 18.5 mmHg
Index of air trapping	1.9 $\pm$ 0.9 %	16.3 $\pm$ 4.8 %

46%, 19 cases had shown higher than 56%, or 12 cases had shown higher than 66% of the RV/TLC ratio out of 108 cases with the senile pulmonary emphysema.

B. *Maximum Breathing Capacity and Timed Vital Capacity:*

Decrease in maximum breathing capacity and slight increase in resting minute ventilation had resulted in decreased ventilation reserve.

The timed vital capacity in the 1st second had significantly decreased, which was rather significant than the decrease in one-stage vital capacity, and therefore the percent timed vital capacity versus one-stage vital capacity had significantly decreased. But decrease in those timed vital capacity or percent timed vital capacity was also significant in cases with senile pulmonary emphysema as compared with those in cases of chronic pulmonary emphysema.

The relationship between the timed vital capacity in the 1st second and the RV/TLC ratio was studied. The decrease in the timed vital capacity was not so significant in cases with slightly elevated RV/TLC ratio, but according to the elevation in the ratio the tendency to decrease in the timed vital capacity was significant. However in some cases of senile pulmonary emphysema with slightly elevated RV/TLC ratio remarkable decrease in timed vital capacity had been shown.

Significant decrease in maximum breathing capacity in cases with chronic pulmonary emphysema which accompanies significantly increased index of air

trapping was found and somewhat reverse correlation between maximum breathing capacity and index of air trapping had been revealed. But in some cases with senile pulmonary emphysema significant decrease in maximum breathing capacity was found without accompanying any significant air trapping (Fig. 6).

Fig. 6 Index of air trapping and maximum breathing capacity.

Abscissa: Index of air trapping (%)
Vertical: Maximum breathing capacity (obs/pred)

Fig. 7 Timed vital capacity and maximum breathing capacity.

Abscissa: Timed vital capacity in the 1st second (cc/sec)
Vertical: MBC(L/min.)

Percent timed vital capacity in the 1st second and maximum breathing capacity had shown positive correlation. The ratio of maximum breathing capacity versus timed vital capacity had studied in cases of healthy aged, in chronic pulmonary emphysema, and in the senile pulmonary emphysema. The ratio had been revealed 42.2 ± 3.9 in the healthy aged, 35.2 ± 3.7 in cases with chronic pulmonary emphysema, and 47.6 ± 5.0 in cases with senile pulmonary emphysema to show significant difference in each cases. The fact that the larger ratio had been revealed in cases with senile pulmonary emphysema as compared with that of the healthy aged may be explained by the significant difference between retarded maximum expiratory flow rate as compared with larger maximum inspiratory flow rate during the maximum stroke of effort ventilation (Fig. 7).

ALVEOLAR FUNCTIONS IN THE SENILE PULMONARY EMPHYSEMA

A. *Intrapulmonary Distribution of Inspired Gas:*

In most cases with senile pulmonary emphysema, despite of the remarkable increase in functional residual capacity, increased alveolar ventilation had compensated the rate of washout of alveolar nitrogen. The average value of distribution indicis (observed) and (calculated) had remained within normal limit in cases with senile pulmonary emphysema whereas those value had been revealed rather smaller values in cases with chronic pulmonary emphysema (Fig. 8).

Fig. 8 Gas distribution curve and oximeter rate in cases with senile pulmonary emphysema, before and after administration of respiratory analeptics.

Fig. 9 Maximum breathing capacity and ΔN_2 .

Abscissa: Maximum breathing capacity (obs/pred)

Vertical: ΔN_2 (%)

Terminal N_2 concentration had sometimes revealed abnormally large value because of the significant transient phase in the gas distribution curve and index of intrapulmonary gas mixing had also sometimes increased. ΔN_2 was rather small to show the normal value in cases with senile pulmonary emphysema. In cases with chronic pulmonary emphysema ΔN_2 and percent maximum breathing capacity had shown somewhat reverse correlation, but in cases with senile pulmonary emphysema significant decrease in maximum breathing capacity had been found despite of smaller ΔN_2 (Fig. 9).

B. *Oximeter Rate:*

Normal arterial O₂ saturation had usually been revealed in many cases observed, but some of them had shown lower arterial O₂ saturation below 80%. Rather slight decrease in arterial O₂ saturation in cases with senile pulmonary emphysema as compared with that in chronic pulmonary emphysema. Any significant correlation between arterial O₂ saturation and RV/TLC ratio had not been found.

Retardation in the saturation time had been found. In some cases with chronic pulmonary emphysema significantly retarded saturation time had also been revealed, but the saturation time in 107 cases out of 206 emphysematous patients observed had remained within normal limit. In cases with senile pulmonary emphysema only 23 cases out of 66 cases observed had shown normal saturation time.

DIXST, which represents the relationship between the gas distribution curve and the oximeter rate, had remained within normal limit or had shown rather smaller values in cases with chronic pulmonary emphysema whereas that had shown rather large values over normal limit in cases with senile pulmonary emphysema.

CLASSIFICATION OF THE VENTILATORY FUNCTIONS IN THE AGED

The ventilatory functions in those cases who had received the pulmonary function tests for the purpose of health examination will be surveyed. Those cases, as referred already, had received the pulmonary function tests as a part of detailed medical checkups and, therefore, some of them had revealed any physiological or roentgenological evidence of pulmonary disease clinically, but others did not revealed any clinical abnormality. For the convenience's sake the discussion will be made by dividing those observed cases into 3 groups concerning with age. Cases of age 40 or younger were called as the younger group, cases between age 41-50 were called as the group of middle aged, and the cases of age 51 or older were called as the aged group.

Generally the numbers of cases with normal ventilatory functions were relatively few. In the younger group such physiologically normal cases were found in 48% of the observed cases. A fewer physiologically normal cases were found in the group of middle aged and the smallest numbers of such cases were found in the aged group. In the younger group the restrictive impairment was found most abundantly and the expiratory incompetency was not dominant. On the contrary the expiratory incompetency with or without restrictive ventilatory impairment was most dominant in the aged group. Numbers of cases

with purely restrictive ventilatory impairment were decreased as compared with the younger group whereas the numbers of cases with pure expiratory incompetency had increased in the aged group. In the younger group the obstructive ventilatory impairment, which is characterized by the increased index of air trapping, were found only 4% of the observed cases whereas in the aged group it was found more than 19% to show the remarkable increase with aging. But in the aged group the expiratory incompetency had been revealed more frequently than the obstructive ventilatory impairment and there were many cases with non-obstructive expiratory incompetency.

It may be concluded that the restrictive ventilatory impairment plays the leading factor in the ventilatory involvement in the younger group whereas the expiratory incompetency plays the leading factor of the ventilatory involvement in the aged group (Table 4).

Table 4
Classification of Ventilatory Impairment

Types of ventilatory functions	Age groups		
	40 or younger	41-50	51 or older
Normal	30 (48 %)	61 (36 %)	113 (31 %)
Restrictive	20 (32 %)	36 (21 %)	52 (14 %)
Combined, obstructive	1 (1 %)	5 (3 %)	21 (6 %)
Combined, non-obstructive	4 (6 %)	10 (5 %)	39 (11 %)
Expiratory incompetent, obstructive	2 (3 %)	17 (10 %)	48 (13 %)
Expiratory incompetent, non-obstructive	6 (10 %)	42 (25 %)	89 (25 %)

Figures in the parenthesis represent the percentage in the same age groups.

The percentage frequency of the numbers of cases with chronic pulmonary emphysema and of the senile pulmonary emphysema in every age groups was

Table 5
Pulmonary Emphysema in Various Age Groups

Age groups	No. of cases observed	No. of senile emphysema	No. of chron. pulm. emphysema
—35	44	0	8
36—40	21	0	2
41—45	66	7	6
46—50	77	14	8
51—55	97	19	7
56—60	98	18	13
61—65	60	10	10
66—70	36	7	4
71—	4	1	0

Fig. 10 Percent frequencies of pulmonary emphysema in various age groups

studied. The percent frequency of the cases with pulmonary emphysema increased according with age. It was very scarce in such senile pulmonary emphysema of non-obstructive type in the age groups of 40 or younger. Remarkable increase in the percent frequency of such senile pulmonary emphysema between age groups of 41–50 and slow increase in it in the age groups of 51 or older were revealed. The percent frequency of such senile pulmonary emphysema was found about 20% in the aged group (Table 5).

CONSIDERATION AND CONCLUSION

The author has presented the fundamental physiological aspects of obstructive and non-obstructive expiratory incompetency through the pulmonary function tests in cases with chronic pulmonary emphysema and with manifested bronchial asthma. Baldwin et al. have classified the impaired ventilatory functions into two basic types of "restrictive" and "obstructive." Miller et al. have divided those impaired ventilatory functions into 3 types of restrictive, obstructive and combined involvement. Meneely had emphasized that such expression of obstructive impairment should be used only in the typical cases. Meneely et al. have described such "obstructive impairment" as "decreased velocity of air flow." But such decreased velocity of expiratory air flow may be caused by the loss of elasticity in lung tissues, by increased tissue resistance for the deformity of lung and thorax, or by the weakness of respiratory muscles as well as by any obstructive changes in the bronchial airways. Hence the author has defined the expiratory incompetency of obstructive and non-obstructive types with special reference to the air trapping. According to this referring criteria the senile pulmonary emphysema of non-obstructive type had been introduced. But

practically it is often difficult to give any definite identification between the chronic pulmonary emphysema of obstructive type and the senile pulmonary emphysema of non-obstructive type because it is expected to be existed many transient types of pulmonary emphysema. For example it may be revealed any obstructive ventilatory impairment in cases with senile pulmonary emphysema when she is complicated any airway infection and furthermore those cases may often be expected to be shifted for the chronic obstructive pulmonary emphysema if the longstanding obstructive expiratory incompetency caused by retension of bronchial drains should be existed. It is difficult to find any difference physiologically between such obstructive ventilatory incompetency in cases with senile pulmonary emphysema and those in cases with chronic pulmonary emphysema which accompany the obstructive expiratory incompetency predominantly.

257 cases with chronic pulmonary emphysema and 108 cases with senile pulmonary emphysema have had found in those 365 emphysematous cases presented in this paper. It is interesting to find the facts that the chronic pulmonary emphysema had been found dominantly in the cases who received pulmonary function tests because of their complaints of dyspnea whereas the senile pulmonary emphysema had been found frequently in cases who received the pulmonary function tests for the purpose of medical examination to check the condition of health. This represents that the senile pulmonary emphysema does not necessarily accompany any signs and symptoms, but if chronic bronchitis or other bronchial infection should be accompanied by the referring emphysema it might consequently be shifted for the chronic pulmonary emphysema of obstructive type. It is believed to have any clinical importance because the senile pulmonary emphysema may be found frequently in the aged and because the advanced senile pulmonary emphysema with bronchial infection may often restrict the work tolerance (Table 6).

Table 6
*Numbers of Cases with Chronic Pulmonary Emphysema
and with Senile Pulmonary Emphysema*

Group	No. of chronic pulm. emphysema	No. of senile pulm. emphysema	Total
A	53	76	129
B	204	32	236
Total	257	108	365

Group A: Cases who had received the pulmonary function tests as a part of medical examination to check the condition of health.

Group B: Ambulatory or hospitalized patients with suspected pulmonary emphysema.

The senile pulmonary emphysema has been introduced as the "small lunged emphysema" or "atrophic emphysema." But "small lunged" or "atrophic" pulmonary emphysema is defined from the anatomical point of view. "Small lunged" or "atrophic" does not directly mean any decrease in total lung capacity or functional residual capacity. There may not be existed any correlation between the total lung capacity and the weight of the excised lungs. Therefore those definitions of senile pulmonary emphysema presented by the author may not interfere those pathoanatomical findings of "small lunged" or of "atrophic." Further studies to identify both senile pulmonary emphysema defined from the pathoanatomical standpoint and that defined from the physiological standpoint are expected.

SUMMARY

1. The definition of expiratory incompetency of obstructive and of non-obstructive type is introduced using the vital capacity, the timed vital capacity, and the index of air trapping.
2. Physiological aspects of the obstructive ventilatory involvement is discussed with special reference to the index of air trapping.
3. The senile pulmonary emphysema is defined from the clinico-physiological standpoint.
4. The ventilatory and alveolar functions of the senile pulmonary emphysema are discussed in comparison with those of the chronic pulmonary emphysema.
5. Clinical importance of the senile pulmonary emphysema is emphasized with regard to the ventilatory functions in the aged.

ACKNOWLEDGMENT

It is a pleasure to record here a debt of gratitude to Professor Jiro Ishida M.D. for his kindness in giving much valuable advice during the work and in reading the original manuscript. Also the authors desire to acknowledge the assistance rendered in this investigation through a grant from Rockefeller Foundation (RF 52095).

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