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EFFECT OF UNILATERAL
GLOMECTOMY ON THE BLOOD GASES
OF PATIENTS WITH
BRONCHIAL ASTHMA AND OBSTRUCTIVE
PULMONARY EMPHYSEMA

By

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In the treatment of bronchial asthma several operative procedures involving the autonomous nervous system and peripheral chemoreceptors have been advocated (see *Fuchs & Gronemeyer* 1961). The most promising of these is the unilateral removal of the carotid body (*Nakayama* 1942). Nakayama himself published in 1961 results of 3914 glomectomies, and since then several large series have been presented (*Overholt* 1962, *Segal & Dulfano* 1965, *Takino & Takino* 1965). In Finland the effect of glomectomy was studied by *Nordström* 1964 and by *Saarni & Juselius* 1965. The results of different authors show, however, large variation. While some authors claim a definite improvement in most patients after glomectomy, others find the treatment to be of little or no benefit. According to *Takino & Takino* the improvement even in successful cases is only temporary. This discrepancy in the results may be partly due to differences in the choice of patients and in the interpretation of the results. The criteria of improvement were mostly clinical and, to a great extent, subjective, such as the need of corticoids and other medication, subjective well-being and ability to work. The observation time in most studies also was too short to allow evaluation of the persistence of the result.

The physiological basis of glomectomy as the treatment of bronchial asthma is the observation that carotid body stimulation increases the tone of the bronchial muscle (*Daly & Schweitzer 1951, Nadel & Widdicombe 1962*), and that asthmatics show an enhanced ventilatory response to carotid body stimulation by cyanide, which is depressed by glomectomy (*Takino & Takino*).

The main function of the carotid bodies, however, is concerned with the chemoreflexory regulation of respiration. Arterial hypoxia causes increased activity in the chemoreceptors of the carotid bodies, which is transmitted to the respiratory center through the carotid nerves (glossopharyngeus). Increased carbon dioxide tension probably is of minor importance for the carotid chemoreflexory mechanism, since carbon dioxide is a more potent stimulant of the respiratory center chemoreceptors which, on the other hand, are insensitive to hypoxia. Thus, the organism can be alerted to a serious decrease of the arterial oxygen tension only by the peripheral chemoreceptors. Their function is especially important in subjects with longstanding respiratory insufficiency and carbon dioxide retention, as in these subjects the respiratory center gradually becomes less sensitive to hypercapnia. Removal of even one of the carotid bodies may thus weaken an emergency respiratory reflex, and might prove risky in patients with advanced respiratory insufficiency.

The purpose of the present study is to evaluate the effect of unilateral glomectomy on the respiratory function on the basis of arterial oxygen and carbon dioxide values, and to compare the effect of glomectomy in patients with purely spastic airway obstruction without structural changes of the lungs (bronchial asthma) and in patients with advanced obstructive insufficiency with structural changes of the lung parenchyma (pulmonary emphysema).

MATERIAL AND METHODS

The patients investigated were chosen to represent pure, uncomplicated bronchial asthma and obstructive emphysema with structural changes in the lungs.

The asthmatics were 25 in number (14 women and 11 men). Their ages ranged from 17 to 69 years. The group of emphysematics comprized 6 women and 4 men (age range 60-80 years). All subjects of this group had clinical, roentgenological and physiological findings suggestive of advanced obstructive disease.

The patients suffering from asthma were studied before the operation, on the first post-operative day and one month after the operation. In the emphysematics the blood gas determinations were made before the operation, 10-30 days after the operation, and in a few cases controlled 2-4 months after the operation.

The carbon dioxide tension was measured by the Astrup micro-method (Siggaard-Andersen *et al.* 1960) from the fingertip arterial capillary blood. The oxygen saturation of arterial blood was measured by ear oximetry (Atlas oximeter). Both these methods require a good hyperemia at the site of blood removal in order to give reliable values for arterial blood. In old people with impaired peripheral circulation full hyperemia may be difficult to obtain, and this may slightly invalidate the results in the series of emphysematics. However, only patients in whom a good hyperemia could be induced were accepted to the series, so this risk was minimized.

RESULTS

In the asthmatics the arterial carbon dioxide tension before the operation usually was within normal limits (mean 39.2 ± 0.7 mm Hg) and the arterial oxygen saturation slightly lowered (mean 86.4 ± 1.0 per cent). None of the patients had a frank hypercapnia ($p\text{CO}_2 > 45$ mm Hg) and only one had a markedly lowered arterial oxygen saturation (< 80 per cent). This patient had a lowered carbon dioxide tension before the operation (32 mm Hg), but developed, after the operation, a marked hypercapnia. In addition, two patients had preoperative carbon dioxide values < 35 mm Hg; in one the carbon dioxide value became normal after the operation, while in the other a slight hypocapnia persisted throughout the experimental period. The latter patient had a mild hypoxia, which was slightly alleviated after the operation.

On the first post-operative day the carbon dioxide tension had risen in most subjects (mean 42.1 ± 0.9 mm Hg), 5 patients had a hypercapnia ($p\text{CO}_2$ between 45 and 50 mm Hg). In the oxygen saturation no significant changes were noted as compared to the initial value (mean 86.4 ± 1.1 per cent). 30 days after the operation the carbon dioxide tension had fur-

ther risen from the first post-operative day (mean 44.1 ± 1.4 mm Hg), 7 patients had values higher than 45 mm Hg, in 3 subjects the values were between 50 and 60 mm Hg. The oxygen saturation showed a slight average decrease as compared to the pre-operative and the first post-operative values (mean 83.4 ± 2.1 per cent), the individual variation however, was, large. No significant correlation was found between the post-operative hypercapnia and the pre-operative carbon dioxide or oxygen values. The mean carbon dioxide and oxygen values in the asthmatics are represented in Table 1.

TABLE 1
*The mean Values of Carbon Dioxide Tension and Oxygen Saturation
in 25 Asthmatic Patients before and after Unilateral Glomectomy.*

	Pre-op.	Post-op. First day	Post-op. 1 month
pCO ₂ /mm Hg	39.2 ± 0.7	42.1 ± 0.9	44.1 ± 1.4
O ₂ -sat.%	86.4 ± 1.0	86.4 ± 1.1	83.4 ± 2.1

The group of emphysematics differed from the asthmatics in that several patients had marked respiratory insufficiency pre-operatively (mean pCO₂ 45.8 ± 2.3 mm Hg, mean O₂ saturation 76.5 ± 2.6 per cent), 4 subjects had a frank hypercapnia (pCO₂ > 45 mm Hg), in 3 subjects the pCO₂ was at the upper limit of the normal range (45 mm Hg). The arterial oxygen saturation was < 80 per cent in 6 subjects. When re-investigated 10–30 days after unilateral glomectomy the carbon dioxide tension of most patients had further risen (mean 51.9 ± 2.1 mm Hg), only 2 patients had a normal carbon dioxide tension, in others the pCO₂ exceeded 50 mm Hg. As regards the arterial oxygen saturation, most subjects showed a moderate or even marked increase (mean 80.7 ± 2.1 per cent). The improvement was greatest in patients with very low pre-operative oxygen values. When the increase of arterial oxygen saturation was compared to that found in patients treated conservatively for the same period it was found,

however, that hospitalization and routine treatment (*e.g.* control of infections, emptying the airways of sputum, breathing exercises, etc.) of emphysema caused at least as great an alleviation of arterial hypoxemia as glomectomy combined with routine treatment.

Four glomectomized patients were re-investigated after a period of 2-4 months from the operation. In the 3 subjects, who had hypercapnia at the first post-operative control, the carbon dioxide tension was still elevated. The oxygen saturation at 2-4 months after glomectomy did not differ from the first post-operative value. The mean carbon dioxide and oxygen values of the emphysematics are given in Table 2.

TABLE 2
The mean Values of Carbon Dioxide Tension and Oxygen Saturation in 10 Emphysematic Patients before and after Unilateral Glomectomy.

	Pre-op.	Post-op. 10-30 days	Post-op. 2-4 months
pCO ₂ /mm Hg	45.8 ± 2.3	51.9 ± 2.1	50.0 ± 4.7
O ₂ -sat. %	76.5 ± 2.6	80.7 ± 2.1	81.3 ± 3.8

As regards the clinical improvement of the glomectomized patients, approximately one half of the asthmatics reported relief from their symptoms after the operation, while the other half had remained unchanged or become worse. In the group of emphysematics, on the other hand, the clinical result was very poor. In one subject only was there a lasting alleviation of the symptoms, while in the remaining 9 subjects the relief was quite temporary (1-2 weeks) or there was no relief. Two of the patients died of respiratory insufficiency within 4 months from the operation.

CONCLUSIONS

According to the present experiments unilateral glomectomy as a rule brings forth a persistent rise in the carbon dioxide tension. In patients suffering from pure, uncomplicated bron-

chial asthma the hypercapnia usually is of a moderate degree, and probably need not be interpreted as a sign of impaired respiratory function. It may be noted, however, that the highest post-operative carbon dioxide values in the asthmatics were met in subjects with lowered pre-operative oxygen saturation and with carbon dioxide values either at the upper limit or below the normal range (*i.e.* in patients with signs of beginning respiratory insufficiency).

In the group of emphysematics comprising patients with roentgenologically detectable changes in the lung structure and, in many cases, advanced respiratory insufficiency, the post-operative increase in carbon dioxide was more pronounced than in the asthmatics. Several patients developed serious and lasting hypercapnia, and in 2 patients the operation may have been partly responsible for the rapid deterioration of respiratory function leading to death.

Evidently the risk of post-operative hypercapnia and respiratory insufficiency must be seriously considered when planning unilateral glomectomy as treatment for bronchial asthma. While glomectomy may be performed, as it seems, with comparative safety on subjects with pure bronchial asthma of a short duration, it is potentially dangerous in subjects with beginning respiratory insufficiency. Careful clinical, X-ray and physiological investigation of the patient is, therefore, needed before the operation.

On the other hand, glomectomy on patients with pulmonary emphysema should be strongly advised against. The benefit of glomectomy in cases where bronchial spasm is not an important factor is theoretically unfounded, and the risk of developing a serious respiratory insufficiency is considerable.

SUMMARY

Arterial carbon dioxide tension and oxygen saturation were measured before and after unilateral glomectomy in 25 patients with bronchial asthma and 10 patients with pulmonary emphysema.

Glomectomy caused, as a rule, a lasting rise in the carbon dioxide tension, which was slight in the asthmatics but quite marked in most patients with pulmonary emphysema. The oxygen saturation of neither group of patients showed any consistent changes as compared to patients treated conservatively.

It is concluded that the risk of respiratory derangement should be seriously considered when planning glomectomy on asthmatics, especially in patients with preoperative signs of respiratory insufficiency. In pulmonary emphysema glomectomy is not advised.

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