

ANESTHESIA METHODS FOR BRONCHOSCOPY AND THEIR USEFULNESS IN PRACTICE.*

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Bronchoscopy, when introduced into clinical practice about the turn of the Century, was employed chiefly for removal of foreign bodies. In the course of years, the use of diagnostic bronchoscopy has steadily increased.

Bronchoscopy, carried out in deficient anesthesia, is an extremely disagreeable experience to the patient; moreover, the diagnostic value of bronchoscopy in a patient offering resistance is doubtful; and finally, bronchoscopy under such circumstances involves a risk of injury.

Endeavors have, therefore, been made to find a satisfactory method of anesthesia, but the multiplicity of proposals proves the difficulty of the task. The main troubles are that the anesthetist and the surgeon work in the same field and, therefore, easily get in each other's way, and that the field concerned is sensitive with very brisk reflexes.

Formerly, the choice lay between local and general anesthesia, the latter in the form of inhalation anesthesia. Within recent years a number of methods, new in principle, have been introduced. We have found it appropriate to try some of these in practice and attempt to assess their usefulness.

The demands to be made on an ideal method are the following:

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1. A minimum of risk to the patient.
2. Removal of discomfort to the patient.
3. Undisturbed working conditions for the surgeon.
4. Simplicity of technique and apparatus.
5. A short restoration period (of particular importance in cases of out-patients).

Local anesthesia, with or without premedication, was previously the most frequently employed method for adults, and is still used in some cases. With reference to the above-mentioned demands, it is seen that:

1. The method, on the assumption of adequate dosage, fulfills the requirement of safety.
2. In few cases only does it remove the discomfort to the patient.
3. It rarely renders possible undisturbed examination. In cases of nervous patients it is impossible to carry through bronchoscopy in local anesthesia alone.
4. The technique is simple.
5. It is suitable for out-patients.

In cases unfit for local anesthesia inhalation anesthesia was previously the only other possibility. Examination then had to be performed during the restoration period, after the dosage had been stopped. The examination requires deep anesthesia. The degree of the consequent depressed respiration and a possible cyanosis are difficult to follow during endoscopy in a dark room. The anesthetist will often have to intervene while the surgeon is at work, either to ventilate with oxygen or to add a supplementary amount of ether, for instance. In case of difficulty with the introduction of the bronchoscope, a laryngeal spasm may occur, which will often start a series of unpleasant complications. Regarding the above-mentioned demands we have found that:

1. The method is not without risk.

2. The discomfort of bronchoscopy is replaced by discomfort of anesthesia.

3. The surgeon cannot work undisturbed.

4. The technique certainly is simple, but it is difficult to manage in practice.

5. The restoration period is fairly long, and the method, therefore, is unfit for out-patients.

The only cases where inhalation anesthesia may be indicated are those of bronchoscopy in children, where the modern forms of general anesthesia may be difficult to administer. In cases of children with obstructing or potentially obstructing foreign bodies in the air passages any kind of general anesthesia must be regarded as contra-indicated. Non-obstructive foreign bodies in the air passages of children can often be removed in vinyl ether-and-ether anesthesia; but an excellent method has been indicated by Toker, using thiopental-sodium and succinyl-choline-iodide, and cuirass respirator (*vide infra*).

MODERN ANESTHETIC METHODS.

A. Local anesthesia supplemented by general analgesia, obtained with pethidine intravenously.

B. General anesthesia obtained with barbiturates supplemented by short-acting relaxants.

A. Local Anesthesia Supplemented by Pethidine Medication.

A previous investigation showed that endoscopy through the pharynx, including bronchoscopy, could be greatly facilitated by injecting pethidine intravenously, due partly to the depressing effect of pethidine on the laryngeal and pharyngeal reflexes, and partly to the mentally relaxing and pain-stilling action of pethidine in the doses used, an action which may be characterized as one of general analgesia. Not infrequently there is found amnesia with regard to discomfort of the examination.

The method has now been employed for bronchoscopy in more than 400 cases at the Finsen Institute during the past

six years, with an exceedingly favorable result. With reference to the previously mentioned demands we have found that:

1. The risk involved must be supposedly less than that of local anesthesia alone, as the amount of anesthetic, if pethidine is used, can be reduced. Oximetry shows that the reduction of the oxygen saturation in cases with pethidine medication is slight, being of the same order as at bronchoscopy in local anesthesia alone, where a reduction occurs when the bronchoscope causes obstruction, *e.g.*, when it is introduced into one of the bronchi. This can possibly be explained by the way in which the depressing effect of pethidine on the respiration is abolished by the stimulating effect of the intervention itself.

2. Pethidine greatly reduces the discomfort to the patient. Reactions in the form of nausea are rare; the skin occasionally becomes pale and slightly moist, but the blood pressure does not fall, and there is seen only the minor rise in pulse rate which corresponds to the parasympatholytic action of pethidine. Liberation of histamine with transitory redness along the course of the vein has been seen in a few instances, but no bronchospasms or collapse.

3. By employing local anesthesia it has, in the great majority of cases, been possible to carry through undisturbed and thorough bronchoscopy, most often including the taking of biopsy specimens and use of the telescope.

4. The method is simple and, if necessary, can be practiced by the surgeon alone, aided only by a nurse to watch the patient during and after the operation.

5. The method is suitable for out-patients, the majority of whom can resume their daily work after a few hours' rest. After removal of the bronchoscope the cough reflexes will suffice to bring up any blood or mucus.

Technique.

We used between 50 and 200 mg. (on an average about 100 mg.) pethidine in a 1 per cent solution. A good technique of local anesthesia is required to obtain a favorable result.

After careful spraying of the mouth and throat, 8 to 10 ml. of one-half per cent pontocaine with adrenaline 1:200,000 can, with advantage, be injected in between the vocal cords by means of a syringe fitted with a blunt, curved cannula, which can be passed down behind the epiglottis of the sitting patient. The cough produced by the application will spread the injected pontocaine in the trachea and bronchi.

Intravenous injection of pethidine is thereafter started; up to 50 mg. is given within about 30 seconds, and afterwards supplemented according to requirement. Maximum response to intravenously injected pethidine is obtained after a few minutes.

B. General Anesthesia.

The use of barbiturates combined with relaxants was first described about four years ago, and various modifications of the technique have already been suggested. These represent different solutions of the essential problem of oxygenation during the induced apnea.

Evaluation of the barbiturate-relaxant method with regard to fulfillment of the stated demands has shown that:

1. The method involves a much greater risk to the patient than local anesthesia plus pethidine method, because it requires a faultless functioning of a rather complicated technical apparatus, as well as an ideal, preferably firmly established cooperation of surgeon and anesthetist.

Failure of a link in the procedure, *e.g.*, a block in the intravenous cannula, leakage or stoppage of the oxygen supply, trouble with the introduction of the bronchoscope, etc., may within a very short time cause complications, which in the dark room may be difficult to recognize and treat sufficiently early. Experience will reduce the incidence of such complications, but the risk is always present. We have seen no severe complications in our series, but a few times interruption was necessary due to technical difficulties involving a risk of hypoxia.

2. The discomfort to the patient before and during the operation has been eliminated. The discomfort following the

intervention is probably somewhat greater than after local anesthesia supplemented by pethidine intravenously.

3. The method yields very good conditions of operation, varying with the different modifications, (*vide infra*).

4. The method requires the assistance of a specialist in anesthesia.

5. The restoration period is sufficiently short to render the method serviceable for out-patients.

The various principles of oxygen supply and the techniques employed will be briefly reviewed.

I. Intermittent ventilation has been suggested by Churchill-Davison, among others. Premedication with morphine and atropine is given. After intravenous injection of 300 to 500 mg. thiopental sodium and 60 to 75 mg. succinylcholine iodide, hyperventilation is carried out for 30 to 60 seconds, with pure oxygen by means of mask and bag. The vocal cords are thereafter sprayed with a local anesthetic. (This has been done in all modifications of thiopental and succinylcholine anesthesia for bronchoscopy, because the relaxant effect vanishes prior to the effect of the barbiturate, so that without local anesthesia removal of the bronchoscope will often be followed by violent coughing and laryngeal spasm). The bronchoscope is then introduced, while at the same time the patient is ventilated with oxygen as often as possible, through a cut rubber tracheal catheter, passed so far into the Negus bronchoscope that it fits airtight.

Oximetry shows that adequate oxygenation can be maintained in this way. Such frequent ventilations in the bronchoscope are very inconvenient to the surgeon, but they can, to a great extent, be done during intervals of examinations, while the surgeon is changing optical instruments, or the like.

The method takes a certain account of the CO_2 elimination, being, therefore, fit to be used over a fairly long period, providing curacite is constantly added for the purpose of maintaining apnea. Supplementary doses of a barbiturate are rarely necessary, when the examination does not extend beyond 15 to 20 minutes.

II. The oxygen diffusion method has been proposed by Barth for bronchoscopy. This method starts with ventilation, using oxygen for three to five minutes, without reinhalation of previously exhaled air (one-way-valve), whereby the nitrogen of the pulmonary air is replaced by oxygen. Thereafter the barbiturate and relaxant are given, until complete apnea has occurred, which is maintained throughout the intervention. During the bronchoscopy pure oxygen is conducted through a lateral tube in the bronchoscope with side holes.

We found that, using this method, a constant maintenance of apnea is necessary, because otherwise the oxygen in the lungs will be "diluted" again with nitrogen, and the oxygen diffusion to the blood thus be reduced.

Oximetry showed satisfactory values, providing the above requirements are met. As, however, no Co_2 is eliminated by this procedure, apnea lasting more than 15 minutes involves a risk of Co_2 intoxication, cf. Barth's own statement after pCo_2 measurements.

III. The insufflation method has been mentioned by Cheatele and Chambers, and others. After administration of barbiturate and relaxant, the patient's lungs are ventilated two or three times with pure oxygen. The bronchoscope is then introduced, and about one liter of oxygen per minute is conducted through a thin catheter passed down to the carina.

The method was found suitable for very short examinations only (Cheatele and Chambers themselves stated five, or ten minutes at most), because the oxygenation is not reliably effective, and Co_2 is accumulated.

IV. The cuirass respirator method has been indicated by Toker, and Green and Coleman. After administration of a barbiturate, a previously fitted respirator cuirass is placed on the patient's thorax and abdomen, and one makes sure that the respirator functions to satisfaction. Then a relaxant is given, and it is controlled so that the respirator takes over the patient's respiration in a satisfactory way. If so, the anesthesia can be continued as long as is desirable, affording ideal and undisturbed working conditions for the surgeon.

In stocky, fat patients, as well as in patients with a stiff emphysematous thorax, it has been found difficult and in some cases impossible, to obtain sufficient change of air by this method.

The apparatus being large and expensive, the method is usually employed in special wards.

V. *The ventilation bronchoscope* has been constructed by Mündnich and Hoflehner, and its use has been described by Kjaer, among others. It is a Negus bronchoscope, provided with side holes at the distal end, so that both lungs are ventilated, even with the bronchoscope passed down into one bronchus. The upper end can be closed by a glass pane. Through a side inlet close to the upper end of the bronchoscope the patient can be ventilated with gases from an ordinary anesthesia machine.

The patient's lungs can thus be ventilated through the bronchoscope during the whole period of bronchoscopy. If airtight closing round the bronchoscope is desired, this can be obtained by manual pressing of the soft tissue above the larynx against the bronchoscope. During prolonged bronchoscopy it is an advantage to be able to ventilate with a nitrogen oxide mixture, for instance, which allows reduction of the theopental sodium amount used and insures the patient's remaining asleep.

When a telescope is used, the glass pane can be replaced by a rubber diaphragm, through which the telescope can be passed airtight. Biopsy specimens cannot be taken simultaneously with the ventilation, but can be taken during a pause in this, especially if the patient has been hyperventilated in advance.

The method is suitable for bronchoscopies where prolonged and undisturbed examination is desired, *e.g.*, in the teaching of diagnostic bronchoscopy; but it is unsuitable for bronchoscopies for the purpose of taking biopsy specimens.

CONCLUSION.

The practical result of our investigations, in connection with testing of the various methods, is that we still prefer

local anesthesia supplemented by pethidine medication as standard method, especially in cases of old and very sick patients, where this method is supposed to involve the least risk. A few patients with very brisk reflexes, or very nervous patients, in whom it has been found impossible to introduce the bronchoscope after local anesthesia plus pethidine, we prefer to anesthetize with barbiturate and relaxant, and use ventilation bronchoscope or, when biopsy has to be made, the cuirass respirator method. In cases where anatomical conditions render examination in local anesthesia plus pethidine difficult, *e.g.*, a short stiff neck, long teeth, or the like, one must, however, be prepared for difficulties, also when employing the method with barbiturate and relaxant.

SUMMARY.

Early and modern methods of anesthesia for bronchoscopy have been reviewed, with reference to our experience in their use.

Local anesthesia supplemented by pethidine intravenously has been found satisfactory, the method being fairly safe, easy to carry out, and yielding sufficiently good operative conditions in the great majority of patients.

General anesthesia, using barbiturates and short-acting relaxants, yield ideal conditions of operation, but has been found to involve a greater risk to the patient.

REFERENCES.

- GAMMELTOFT, A.; JOHANSEN, S., and RUBEN, H.: *Ugeskr. for læger*, 114:525, 1951.
- CHURCHILL-DAVISON, H. C.: *Anaesthesia*, 7:237, 1952.
- CHURCHILL-DAVISON, H. C.: *Anaesthesia*, 8:128, 1953.
- BUTT, N. S. G.: *Brit. Jour. Anaesthesia*, 24:245, 1952.
- BARTH, L.: *Thoraxchirurgie*. Band 2; Heft 1, 1954.
- MACINTOSH, R. R.: *Anaesthesia*, 9:77, 1954.
- KELSALL, P. D.: *Brit. Jour. Anaesthesia*, 26:182, 1954.
- JOOSTE, K. H.: *Anaesthesia*, 10:59, 1955.
- TOKER, P.: *The South African Med. Jour.*, 29:40, 1955.
- GREEN, R. A., and COLEMAN, D. J.: *Anaesthesia*, 10:369, 1955.
- SHANE, S. M.: *Arch. Otol.*, 62:3, 1955.
- ALVER, LEEK: *Arch. Otol.*, 62:4, 1955.
- CHEATLE, C. A., and CHAMBERS, K. B.: *Anaesthesia*, 10:171, 1955.