CONTROLLED RESPIRATION IN NEUROSURGERY*

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A great deal has been written about the requirements of neurosurgical anaesthesia, but little about the use of controlled respiration for these cases. It appears, however, that the use of controlled respiration in neurosurgery has spread throughout various centres in Australia.

It is intended here to describe a technique for neurosurgical anaesthesia using controlled positive and negative pressure respiration.

Prior to April 1956, an open technique was invariably used at St. Vincent's Hospital, Melbourne, which appeared to give better operating conditions than controlled respiration with intermittent positive pressure. However, since obtaining a Harrington-James respirator an increasing number of cases has been done with controlled positive and negative pressure, until the present when the majority of cases are anaesthetized by this method. It is considered that a soft brain and good operating conditions are more consistently achieved.

TECHNIQUE

Premedication.

This depends on the physical state of the patient. Papaveretum and scopolamine are used for fit adults with a normal intracranial pressure. Graded doses of the same drugs (or occasionally pethidine is substituted for papaveretum) are given even in the presence of a raised intracranial pressure after seeing and assessing the patient. Atropine alone is given for comatose patients.

Morphine causes respiratory depression, but does not appear to increase intracranial tension in the presence of adequate pulmonary ventilation. If no analgesic is included in the premedication either a larger dose of relaxant is needed to settle the patient, or intravenous pethidine is needed during the anaesthetic.

Induction.

Unless the patient is comatose, anaesthesia is induced with sodium thiopentone given in 2.5 per cent solution and followed by 50–100 mg of suxamethonium. A comatose patient is not given thiopentone and suxamethonium only if the laryngeal reflexes are present. The patient's lungs are ventilated with oxygen and after spraying the larynx and trachea with 4 per cent lignocaine, intubated with a number 9 or 10 short bevel cuffed Magill's tube. A pharyngeal airway is also inserted and all connections are checked and firmly strapped in position.

The patient is now ventilated with nitrous oxide (2 litres) and oxygen (1 litre) in a closed circuit with circle absorption. When respiration returns d-tubocurarine (30 mg) is given, and when the patient is settled he is taken into the operating theatre and put into position. Usually another 10 mg of d-tubocurarine is needed during the procedure. In some patients, especially in those undergoing laminectomy, gallamine has been used. In order to ensure that the endotracheal tube is unobstructed, it is advisable to use tracheal suction after positioning.

The rebreathing bag is now detached and the circuit connected to the Harrington-James respirator. The pulmonary ventilation and the degree of positive pressure are adjusted to the individual patient.

An intravenous saline drip is set up in the leg and blood is replaced as it is lost.

Harrington-James Respirator.

The ventilation rate is fixed at 20 per minute. In this apparatus a concertina bag is connected via a gear link system to a sparkless electric motor.

* From a paper read to the Australian Society of Anaesthetists, Adelaide, May 1, 1957.
A crank lowers and raises the link which alters the volume drawn in and out of the bag and, therefore, the pulmonary ventilation. By altering the tension on an ordinary expiratory valve, variations in the negative pressure can be obtained. Decreasing the tension increases the negative pressure.

When adjusting the machine, (1) the endotracheal tube must not be obstructed, (2) the patient must be fully curarized, (3) total ventilation must be adequate for the individual patient. In practice it is aimed to achieve hyperventilation and (4) the amount of positive and negative pressure is adjusted usually to +8, -5 ml of water.

Maintenance

Anaesthesia is maintained with nitrous oxide and oxygen 2 litres—1 litre and intermittent doses of relaxant. It is essential to keep careful records and note the time/dose relationship of relaxant, until the patients' response to the drug can be adequately gauged. During the first two hours approximately 10 mg of d-tubocurarine will be needed every half-hour.

A patient who continues to breathe against the machine and requires abnormally large doses of relaxant, either has an obstructed airway or is being underventilated, both of which lead to a raised carbon dioxide tension in the blood.

If pulmonary ventilation is adequate decurarization is most often shown by movements of fingers and toes and seldom by coughing, bucking or attempts to breathe against the machine.

The average case which has received adequate premedication does not require further doses of thiopentone or intravenous analgesic after induction.

The soda lime must be changed at least every two hours. A careful attention to the details of neurosurgical anaesthetic technique is essential, particularly as regards posture. A negative pressure phase in the respiration will not compensate for an obstructed airway.

Emergence.

At the completion of operation atropine 1.3 mg is given and the carbon dioxide absorber turned off until spontaneous respiration returns. After a long operation with a prolonged period of hyperventilation it appears better to let the patient breathe spontaneously for ten minutes before giving neostigmine so that the respiratory centre can regain its normal rhythm. The pharynx and, if necessary, the larynx are sucked out; atropine followed by neostigmine (2.5 mg) are given and the endotracheal tube removed.

Most patients are awake and responding, before leaving the theatre and the anaesthetist's neurological examination can be carried out.

Discussion

During two years at St. Vincent's Hospital, Melbourne, approximately half the anaesthetics for both routine and emergency operations in the neurosurgical department have been administered by the author. During the first twelve months open circuit was used and during the last twelve months controlled respiration with positive and negative pressure. Detailed records are available of only 100 anaesthetics—72 craniotomies and 28 spinal operations—far too small a number for statistical purposes. It is, nevertheless, a strong clinical impression that we are obtaining better operating conditions with the controlled respiration technique, an opinion shared by the other anaesthetist in the unit.

The demands of neurosurgery vary. This technique cannot be forced on a surgeon who relies on changes in respiration to denote damage to the medulla, hypothalamus, pituitary or third ventricle, and who is worried about the dangers of retraction anaemia in a soft brain. Others, however, find good operating conditions outweigh these disadvantages.

After preliminary tentative trials, gradually the neurosurgeons were completely convinced and now prefer this technique.

The beneficial effects of controlled positive and negative pressure respiration in neurosurgery are mainly two:

Adequate pulmonary ventilation or hyperventilation with the maintenance of the blood carbon dioxide tension at normal or below normal levels despite the use of hypnotic and analgesic drugs. With spontaneous respiration, it is extremely
difficult to avoid respiratory depression and, therefore, some rise in carbon dioxide tension. As cerebral vascular congestion is related to the increased tension of carbon dioxide in the arterial blood, a normal or lowered tension should reduce or prevent it.

The phase of subatmospheric pressure greatly reduces venous bleeding. Controlled respiration with intermittent positive pressure will maintain a normal carbon dioxide tension, but with the loss of negative pressure in the thorax there is an increase in venous pressure which is reflected back to the brain with a considerable increase in venous oozing which would greatly impede the surgeon.

The negative phase in the respiratory cycle compensates for this and lowers the venous pressure and greatly decreases venous oozing. In some cases the ebb and flow of blood in the diploic veins has been seen with a decrease in bleeding during the negative phase of the cycle.

The negative phase has considerable effect on the tension of the brain and the surgeon frequently remarks on the slackness of the brain.

Hypotension.

Hypotension is very rarely needed with this technique as such good operating conditions are obtained. Trimetaphan is reserved for vascular surgery where a high arterial tension makes the operation dangerous.

When induced hypothermia has been used in Melbourne, shivering has been controlled with curare and, therefore, controlled respiration has been essential.

In summary the advantages claimed for this method are:

1. Induction is both quicker and easier than with an open circuit. Posturing is more easily done without fear of coughing or bucking.
2. The decrease in vital capacity and, therefore, in pulmonary ventilation which occurs when the patient is breathing spontaneously in the lateral and prone positions is easily compensated for. This is particularly useful in the prone position as in chordotomies and laminectomies for malignant disease. In cervical sympathectomies it is possible temporarily to decrease the ventilation if the movement of the pleura worries the surgeon and there is, of course, complete control of the respiration if the pleura is punctured.
3. Coughing is under absolute control—a requisite for neurosurgery. A much smoother anaesthetic without any straining and rise in venous pressure is obtained.
4. The technique can be used for the patient in the sitting position where chlorpromazine is contra-indicated.
5. The bronchitic, emphysematous, heavy smoking patient who is very difficult to anaesthetize on an open circuit is easily handled.
6. Good operating conditions are more consistently obtained.
7. The patients are awake more quickly.
8. It is an impression that blood loss, particularly in laminectomies, is less.
9. The technique is suitable for the aged.
10. Owing to its simplicity and reliability, new registrars learn the technique rapidly.

The disadvantages of the procedure are:
1. Possibility of prolonged curarization following long operations or due to sensitivity to relaxants.
2. Interference with the respiratory centre at operation is masked, e.g. in posterior fossa operations or pituitary tumours.
3. It is not suitable for children with the equipment at present available.
4. If the ventilation for any reason is inadequate very bad operating conditions will result.
5. Occasionally the blood pressure drops following the administration of d-tubocurarine.
6. Excessive bleeding from the skin flaps may occur while sewing up, due to the rise in carbon dioxide tension when the soda lime is turned off, and the patient starts to breathe spontaneously.

CONCLUSION

In conclusion one must remember that neurosurgical anaesthesia is the most humbling of all. Any physiological change is transmitted immediately to the surgeon and many factors can produce a tight brain.

It is impossible to say that this method is better than spontaneous respiration and equally good
operating conditions are produced with perfect open circuit anaesthesia. However, it is not always possible to give a perfect anaesthetic on an open circuit and there are a percentage of patients who are not suitable for this method. It would seem that good anaesthetics are more consistently given with this method and the neurosurgeons appreciate the “slack” brain and good operating conditions.

SUMMARY

A technique of anaesthesia for neurosurgical cases is described in which the patient is fully curarized and pulmonary ventilation achieved by intermittent positive pressure respiration using a subatmospheric pressure in the expiratory phase. The Harrington-James respirator is employed. The apparent advantages and disadvantages of the technique are discussed.

BOOK REVIEW


It is perhaps surprising that there has not been a monograph on the relaxant drugs since the admirable work of McIntyre on curare in 1951. The volume under review produced by Dr. Francis Foldes should therefore find a ready welcome. It is one of the American Lecture Series and, as can be seen from the above details, it is a larger book than many of its forerunners. Information is here in plenty.

There are 414 references in the excellent bibliography at the end of the book, and it is gratifying indeed to find that work outside the United States is given due credit.

Fifty-one pages which form part one are devoted to fundamental considerations concerning the mode of action and pharmacology of these drugs. The arrangement of the former is clear, and here the author has made a useful contribution by his helpful classification of these drugs into depolarizers and nondepolarizers, thus avoiding the ambiguity attendant on the term “competition block”, and also the unnecessary confusion of Bovet's “Lepto” and “Pachy” terminology.

What the author has not done is to attempt any critical assessment of the abundance of work that has been carried out on this subject and on the pharmacology of these drugs. Valuable contributions backed by sound experimentation are not markedly differentiated from work founded on a less firm basis.

The next section of the book, of some 100 pages, goes under the title of “Clinical Uses”. Techniques are given in detail—almost minute detail—and the pros and cons of controlled and assisted respiration, the uses of antidotes, as well as varying sensitivity to the action of muscle relaxant drugs, are discussed. In general, however, it must be confessed that many British anaesthetists will be left wondering at an approach in the clinical field so obviously different from theirs. The emphasis is very much on the use of drugs depressant to the central nervous system helped out by relaxants. It is interesting to find a description of the author's technique using supplementation of anaesthesia by central nervous depressant drugs combined with their antagonists in attempt to avoid their respiratory depressant effects. A number of the opinions expressed in this section of the book are not likely to find ready acceptance on this side of the Atlantic—but that does not necessarily mean that they have been proved wrong. That would call for yet another book.

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