EXPERIENCE WITH A PORTABLE PERIPHERAL NERVE STIMULATOR

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THE DEPARTMENT OF ANAESTHESIA at the Toronto Western Hospital recently introduced a peripheral nerve stimulator† into routine clinical practice in the operating room. Although the device is considered by many to be purely a laboratory tool, we have been impressed by its usefulness and by the ease with which classical muscle responses can be obtained and (with experience) interpreted.

Churchill-Davidson,¹ Katz,^{2,3} and others⁴ have extensively investigated the response of muscle to nerve stimulation under various conditions. Their procedures will not be reviewed here. Both investigators used a nerve stimulator in routine clinical practice, and both have emphasized certain features which may be shown by this procedure.^{5,6} Principally these are:

1. The degree of neuro-muscular block.
2. The type of neuro-muscular block.

We must emphasize that the nerve stimulator does not give an accurate numerical measurement that can be read from a dial. Conclusions are based on a visual assessment of muscle response, the validity of which depends for the most part on the experience of the observer. For optimum results we believe:

1. The apparatus should be used almost as routinely as a blood-pressure cuff. It should not be left to gather dust in a cupboard and then brought out only when an emergency arises.

2. It is just as essential to obtain a response before a muscle relaxant is given as it is to take a blood pressure reading before an anaesthetic is started. The magnitude of the responses are subject to individual variation and, of course, technical error.

3. Needle electrodes and continuous monitoring as recommended by Katz⁶ should be used.

4. For extended periods of relaxation a non-depolarizing relaxant is preferred to a depolarizing one used either as a continuous drip or intermittently. This is for reasons apart from the development of dual block (see below).

We have found it easy to demonstrate even to the most sceptical observer the development of "fade," "tetanus," and "post-tetanic facilitation." Most of our observations have been made with the non-depolarizing relaxants, since we rarely use intermittent or continuous depolarizing drugs for extended relaxation. However, limited trials of continuous and intermittent succinylcholine have shown that the pattern of recovery after depolarizing relaxants have been used is not always predictable from the response to ulnar-nerve stimulation. This has not been our experience with the non-depolarizing drugs.

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†"Block-Aid" Monitor, Burroughs Wellcome & Co. (Canada) Ltd.

Our principal observations when using non-polarizing relaxants have been:

1. Adequate abdominal relaxation is obtained with about 90 per cent decrease in muscle twitch. However, closure of the upper abdominal peritoneum may require complete obviation of response.

2. The first sign of recovery of muscle power after complete paralysis is post-tetanic facilitation. This may be observed with or without visual evidence of tetanus.

3. If the twitch response is of large magnitude, post-tetanic facilitation may be better demonstrated with the power input of the stimulator set at a lower level, thereby making the difference between the two responses more obvious.

4. It has been a casual observation that the first twitch-response after the tetanus has not always been facilitated. This has yet to be substantiated in a large number of cases.

5. The dosage of prostigmine needed to antagonize any residual relaxant can be accurately titrated. This has led in most cases to the use of higher dosages than would have been given if the respiratory function had been the only criterion used. However, lower dosages have also been given (see case reports).

CASE REPORTS

Case 1

A 22-year-old woman received 30 mg. of curare during the course of an anaesthetic given for a closed mitral commissurotomy. At the end of the procedure (one hour after the relaxant was given), she was apnoeic and was easy to inflate by manual ventilation. However, the muscle response to nerve stimulation was normal, and over a period of 15 minutes respiratory function became satisfactory (taking into consideration the thoracotomy wound and the disease process itself). No prostigmine was given, and we returned her to the recovery room with the knowledge that any subsequent respiratory insufficiency would not be due to residual curarization.

Comment

In this case two drugs (atropine and prostigmine) with potentially dangerous cardiac effects for this particular patient were avoided. This was somewhat surprising to us, because the dose of curare was quite large and had been given only one hour previously. Before the use of the nerve stimulator, we would certainly have used an antagonist.

Case 2

A 35-year-old man weighing 230 pounds received 30 mg. of curare during the course of an anaesthetic given for cholecystectomy. One hour later, at the end of the procedure, he was still apnoeic with no response from the nerve stimulator. A total dose of prostigmine of 4.0 mg. was given before the muscle response returned to normal, although respiratory function appeared adequate after 3.0 mg.

Comment

The reverse situation from case 1. In this instance the effects of the curare lasted a much longer time than would have been expected. The dosage of prostigmine given for reversal was much higher than would have been given before the use of the nerve stimulator.

Case 3

A 40-year-old man was given intermittent succinylcholine in doses of 60 mg. during the course of a cholecystectomy. Respiratory movement and increased abdominal muscle tone returned 15 to 30 seconds before any muscle response was obtainable from nerve stimulation. It was found impossible to assess further dosage before operating conditions became difficult.

Comment

As stated previously, we are less happy about the predictability of response when using depolarizing drugs. This case illustrates that point.

Case 4

During the early phase of the use of this equipment a patient developed respiratory distress in the recovery room after being given an arbitrary dose of 2 mg. of prostigmine at the end of the operative procedure. The nerve stimulator indicated that residual curarization was present. A further 1.5 mg. of prostigmine was required before reversal was complete and respiratory function became satisfactory.

Comment

With the use of this equipment residual curarization need not be a recovery-room problem.

SUMMARY

The peripheral nerve stimulator has been shown to be of great value in routine anaesthetic practice. Some reservations have been made regarding its use with depolarizing relaxants. It has been emphasized that optimum results can be obtained with regular use of the instrument.

REFERENCES

1. CHURCHILL-DAVIDSON, H. C. & CHRISTIE, T. H. Diagnosis of Neuromuscular Block in Man. *Brit. J. Anaesth.* 31: 290 (1959).
2. KATZ, R. L. Comparison of Electrical and Mechanical Recording of Spontaneous and Evoked Muscle Activity: The Clinical Value of Continuous Recording as an Aid to the Rational Use of Muscle Relaxants during Anaesthesia. *Anesthesiology*. 26: 204 (1965).
3. KATZ, R. L. & WOLF, C. E. Neuromuscular and Electromyographic Studies in Man: Effect of Hyperventilation, Carbon-Dioxide Inhalation + d-Tubocurare. *Anesthesiology*. 25: 781 (1964).
4. FINK, B. R. A Method of Monitoring Muscular Relaxation by the Integrated Electromyogram. *Anesthesiology*. 21: 178 (1960).
5. CHURCHILL-DAVIDSON, H. C. A Portable Peripheral Nerve Stimulator. *Anesthesiology*. 26: 224 (1965).
6. KATZ, R. L. A Nerve Stimulator for the Continuous Monitoring of Muscle Relaxant Action. *Anesthesiology*. 26: 832 (1965).