A NEW DEVICE FOR MONITORING FORCE OF THUMB ADDUCTION

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Early attempts to measure the degree of neuromuscular block made use of the dynamometer for determining hand grip strength or devices to assess the maximal voluntary efforts of the abdominal recti (Mushin et al., 1949; Organe, Paton and Zaimis, 1949). Other methods involved measuring respiratory activity either by spirometry or by recording diaphragmatic movements on a fluorescent screen (Guild, 1950; Unna et al., 1950).

Measurement of a voluntary contraction cannot be carried out during anaesthesia and even in conscious volunteers its accuracy and that of respiratory measurements is limited by the ability of the subject to reproduce a given effort. Also measurement of respiratory parameters gives a poor estimate of neuromuscular transmission. Quite apart from the indirectness of the method, variations due to apprehension in the conscious volunteer or to other factors, such as alteration in arterial carbon dioxide tension in the anaesthetized subject, invalidate the results.

Motor nerve stimulation with supramaximal stimuli overcomes these disadvantages and has been widely used in experimental work with animals and later with human subjects. For example, Thesleff (1952) working with anaesthetized patients, applied supramaximal stimuli to the ulnar nerve at the elbow and recorded the twitches produced in the fourth and fifth digits. Unfortunately, however, there was a considerable fluctuation in the strength of contraction obtained in the absence of relaxants. Hanquet (1954) applied submaximal isolated stimuli to the median nerve of anaesthetized patients and recorded the twitches produced in the third finger, but again the recording showed great fluctuation.

In order to measure the tension developed in the adductors of the thumb or abductors of the little finger with the required degree of accuracy, Bigland and Lippold (1954) found that it was essential to fix the arm and hand rigidly by encasing the forearm and hand in a plaster cast which was split into halves and had opening for the thumb and little finger. Mapleson and Mushin (1955) used the outstretched left arm with the forearm strapped down to an aluminium arm rest which formed the neutral electrode, the active electrode being applied over the median nerve at the wrist; contraction of the thumb muscles was recorded by placing a leather strap round the thumb and connecting it to a lever system which moved a hot wire pointer over heat-sensitive paper on a kymograph drum. In 1964 they modified this method by strapping the forearm into a plaster cast made individually for each subject; this, it was found, helped to obtain a more stable isometric contraction.

Katz, Wolf and Papper (1963) fixed the patient's hand on a specially constructed arm board (moulded plaster) and measured the adduction of the thumb in response to ulnar nerve stimulation by a force displacement transducer (Grass Model FT-03), the results being recorded on a polygraph. More recently Katz (1968, personal communication) designed an apparatus in which the forearm and hand were immobilized in a splint, the thumb being abducted in a yoke connected to the same type of transducer. The thumb should be carefully positioned in full abduction. Wals, Lebowitz and Dillon (1968) suggested another means of fixing the Grass (Model FT-03) transducer. The latter was attached to a rubber bicycle handlebar grip, which was secured to the hand of the patient and the thumb was aligned to the lug of the cantilever of the transducer. This might offer inconvenience to the patient's fingers, because of the narrow space between the handle and the cannon plug of the transducer. Besides, in both devices, too many joints makes it likely that the system may become unstable.

Figure 1 shows a new device in which the transducer, Ethers type UF1, which is a tensile/
Fig. 1
Transducer embedded in a piece of wood and assembled in the form of a hand grip.

Fig. 2 (right)
Showing the device fixed in place in the hand by means of four pieces of transparent adhesive tape.

Fig. 3 (below)
(A) 5 mg Pancuronium bromide. (B) No twitch for 40 minutes. (C) Tetanus; 50 c.p.s. for 3 seconds.
(D) Neostigmine 5 mg.
compressive load transducer,* range 32 ounces, was mounted on a piece of light wood, shaped to hand grip. The transducer is separated from the patient's hand by a piece of foam and polyethylene sheet. The patient is asked to hold the device firmly in the hand but without squeezing, or it can be applied in the same way while the patient is unconscious. The device is secured in place by four strips of adhesive tape (fig. 2). The thumb is aligned to a platform mounted on a threaded 10 BA rod which is connected to the light armature of the strain gauge. The arm is outstretched and secured on an arm board rest by another two adhesive tapes, one over the middle of the forearm and the other over the wrist. The baseline was found to remain stable and was unaffected on movement of the operating table or the patient. It was possible to attach the transducer to the hand in less than 2 minutes and it was found that the device remained secure for as long as was required. This transducer thus provides a more compact device, simply secured and capable of use with a hand of any size or shape.

Figure 3 illustrates a sample tracing obtained with this apparatus. The tracing was recorded on a single channel Devices recorder with a paper speed of 0.25 mm/sec. The quality of the tracing is dependent mainly on the way the hand is fixed to the transducer. Further work is in progress to make a comparative study on this device and the other two devices using FT-03.


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REFERENCES


Hanquet, M. (1954); quoted from Mapleson and Mushin (1955), Anaesthesia, 10, 265.


BRISTOL ANAESTHETIC CLUB

Programme for Spring Term, 1970

FEBRUARY 4, School of Nursing, Bristol Royal Infirmary.

"Dental Anaesthesia", Professor E. A. Cooper (Newcastle upon Tyne).

MARCH 4, Sisters' House, Frenchay Hospital, Bristol.

"Anaesthetic Wanderings", Dr. A. W. Diamond (Denmark), Dr. G. Wray (Denver), Dr. J. S. M. Zorab (Vietnam).

APRIL 1, Regional Blood Transfusion Centre, Southmead Hospital, Bristol.

"The Use of Intrathecal Hypertonic Saline for Intractable Pain", Dr. D. D. B. Morris (Bournemouth).

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