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Short Report

Changes in F wave size during dentatotomy

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SUMMARY Mean F wave size has been used in the present investigation to monitor motoneuron excitability in patients undergoing a dentatotomy for the relief of spasticity. Mean response size was reduced by electrical stimulation in the dentate nucleus and following the production of lesions in this nucleus. Both ipsilateral and contralateral effects have been demonstrated.

There is evidence that the size of the F wave[1] is dependent on motoneuron excitability.[2–4] If such a relationship exists, procedures which are carried out to relieve spasticity might be expected to change F wave size[5] and it might therefore be possible to use the F wave as an objective monitor during operations for the relief of spasticity. We have investigated this possibility in a small group of severely spastic patients undergoing operations on the dentate nucleus of the cerebellum.[6–8]

Materials and methods

Results are described from operations on six male and female patients aged from eight to thirty eight years. All were suffering from severe spasticity, which had resulted from post-traumatic intracerebral haemorrhage, spontaneous intracerebral haematoma, subarachnoid haemorrhage or from a porencephalic cyst with unilateral cerebral atrophy. In three patients, spasticity was unilateral, while in the remaining three it was bilateral. The operations were carried out under local anaesthesia in four patients and under a light general anaesthetic in two patients.

EMG recordings were made from abductor pollicis brevis. In some patients an intramuscular electrode was used, while in others superficial electrodes were placed on the skin over the thenar eminence; similar results were obtained using both techniques. The activity was amplified and displayed using conventional circuitry (Medelec MS6) and recorded on magnetic tape. Square wave (0·1 ms) stimuli were applied to the median nerve at the wrist and the intensity was adjusted until it was 1·5 times that value which gave a maximum M response in the muscle. These stimuli gave F waves with latencies of 25–35 ms in adult patients and 19–23 ms in one 8-year-old patient. In the course of the operation, F wave size was estimated by eye; subsequently, each response was rectified and integrated, using a Datalab 4000B microprocessor, to give an accurate value for F wave size.

After attaching a stereotaxic frame, an electrode was passed through a posterior fossa burr hole and into the cerebellum. The angle of penetration of the electrode and estimated depth of the dentate nucleus were determined by reference to stereotaxic coordinates. Schvarcz *et al*[9,10] have shown that when an electrode is placed in the dentate nucleus, repetitive stimulation results in a reduction in muscle tone. In our patients, therefore, stimuli (50 Hz, 2 ms duration, 0·5–6 v) were applied through the cerebellar electrode at each of several points along its trajectory and the effect on F wave size assessed. Because of the large variability in F wave size, the mean size of the response to at least 10–20 stimuli was estimated. This procedure was followed in each of several electrode penetrations. When an effective site had been identified, a lesion was made, using a Radionics 1·8 x 3 mm electrode, heated to 75°C for 60 s. F wave size was assessed before and after making the lesion. One or more lesions were made until a satisfactory response (assessed clinically and by use of the F wave) was achieved.

Results

F wave size showed a wide variability from one stimulus presentation to another (see figure): the average standard deviation in the control series carried out on the six patients was 80% of the mean F wave size. This emphasises the importance of using reasonably large numbers of responses in estimating the effects of any procedure on F wave size.

IPSILATERAL DENTATOTOMY

Electrical stimulation in the cerebellum had little effect on F wave size until the electrode tip was within 5 mm of the dentate nucleus (estimated from stereotaxic coordinates). In each patient, the point which had maximum effect on F wave size was identified; electrical stimulation at this

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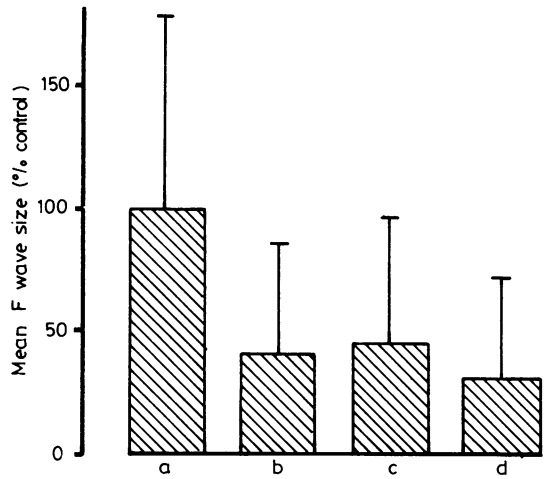

Figure *F wave size at different stages during the operation. Mean F wave size has been calculated from all patients: bars show mean of the standard deviation in each patient. (a) control: (b) F wave size when stimulating at optimum site: (c) F wave size following the production of a lesion at that site: (d) F wave size following the production of all ipsilateral lesions.*

point resulted in a mean reduction of 60% in F wave size (fig b). Despite the large standard deviation in individual F wave size, the reduction was statistically significant in all patients ($p < 0.05$). After cessation of cerebellar stimulation, F wave size returned to the control level. Subsequent electrocoagulation at that site resulted in a mean reduction of 55% in F wave size. Further lesions were then made close to the initial one and the effect of each lesion was again monitored by recording F wave size; it may be seen (fig d) that these brought about a further reduction of approximately 10% in F wave size.

CONTRALATERAL DENTATOTOMY

In three patients, bilateral lesions were made. In these patients, the effect of the subsequent, contralateral dentatotomy was to cause a further reduction in F wave size (mean reduction = 12%).

OTHER FACTORS INFLUENCING F WAVE SIZE

Several other factors were seen to influence F wave size, especially in the conscious patients. Unintentional mechanical stimulation of the dura caused pain and a large increase in F wave size. An episode of nausea followed by vomiting also induced a marked increase in F wave size. Voluntary movement may not only change F wave size but may of course totally obscure the F wave.

CLINICAL ASSESSMENT

On gross clinical testing, all patients were considered to have a significant reduction in tone when the cerebellum was stimulated at points which also gave a reduction in F wave size. After operation, spasticity was found to have been alleviated in all patients.

Discussion

The F wave results from the discharge of motoneurons following their antidromic activation.[11–13] Antidromic invasion of the soma occurs relatively infrequently and therefore only a few neurons in a motoneuron pool give recurrent discharges following supramaximal stimulation of a peripheral nerve.[4] The number of neurons giving this response is modified, however, by the level of motoneuron excitability[3,4] and it is this relationship which provides the possibility for using the F wave in monitoring surgical procedures which are carried out to reduce muscle tone. F wave size can, of course, be affected by other factors, such as pain and voluntary movement[14] and it is therefore important to interpret the results in terms of the overall clinical situation. The large variability in F wave size also necessitates the use of a reasonably large number of stimuli in assessing mean F wave size. Used in this way, however, we suggest that the response can be a useful monitor, aiding the placement of lesions in the dentate nucleus to give an optimum effect in reducing muscle tone.

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