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The Application of Electromyography to Affections of the Facial and the Intrinsic Laryngeal Muscles

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ELECTROMYOGRAPHY is a delicate gauge of the damage to the lower motor neuron and it has proved of value for the accurate assessment of peripheral nerve injuries and the early stages of diseases affecting the lower motor neuron. Among other pathological conditions, it has been an aid in the diagnosis and prognosis of facial and laryngeal muscle affections (Weddell, Feinstein and Pattle, 1944). Muscles which perform finely graded movements such as those of the face and larynx have motor units composed of fewer muscle fibres than those muscles, such as of the limb, which are only capable of much coarser movements. The action potentials are similarly less in duration (2 to 5 milliseconds) and smaller in amplitude (50 to 500 microvolts).

Facial paralysis.—Electromyographic examinations have been carried out in more than 150 cases of facial paralysis due to affection of the lower motor neuron. The cause of the paralysis, in the majority of the cases, can be divided into two clearly defined groups.

In the first group, the paralysis is due to trauma, either direct or indirect, and in the second, the paralysis is due to pressure by inflammatory œdema on the nerve trunk in its course through the temporal bone, resulting in an ischæmic block. In this group can be included the paralysis found in such conditions as Bell's palsy, herpes zoster and otitis media.

It has been found that the facial paralysis following a head injury in the majority of cases is apparently due to an ischæmic block rather than to an interruption of the axons. This would account for the observations of Turner (1944) that the prognosis in facial paralysis of this type is good. 12 cases of traumatic facial paralysis were examined electromyographically. In 4 of these, there was no evidence of denervation and each made a complete recovery, but, in each of the other cases, there was a varying number of axons interrupted. Recovery occurred but associated movements were present in every instance.

The findings suggest that in cases of complete axonal interruption following direct trauma, where there is no gross displacement of the nerve, at least six months should elapse before operative procedures, such as exploration and grafting, are to be considered. In such cases electromyographic examinations are valuable in detecting minimal degrees of re-innervation before the return of functional recovery. In those cases where the skiagrams demonstrate a fracture and displacement of the mastoid tip, earlier operation is justified. In cases of closed head injuries, the prognosis regarding the recovery of facial paralysis is so good that early decompression of the facial nerve is not warranted.

It is not possible by means of electromyographic examination to differentiate between an axonal interruption and a reversible ischæmic block for about twelve to fourteen days following the nerve injury, as it is not until this time that fibrillation commences.

The demonstration of even a single repetitive motor unit action potential is of great prognostic significance in a case in which clinically the paralysis is complete, as it indicates that a few nerve fibres have escaped damage, and therefore suggests that the lesion is "in continuity".

In the cases of the infective group, i.e. Bell's palsy, herpes zoster and otitis media, electromyographic examinations confirm the clinical observations, but, in addition, offer a more detailed analysis of the nature of the paralysis. This is particularly valuable in assessing the prognosis. In mild cases of facial paresis, there was a reduction of motor unit activity in response to a maximum voluntary effort to move the muscles but no other abnormalities. Recovery both clinically and as shown by means of electromyographic recordings was complete within a few weeks. In instances where the facial weakness was more marked and associated with a considerable degree of lower motor neuron denervation, recovery resulted in marked associated movements. This is accounted for by the fact that many of the regenerating axons do not follow their original pathways and dichotomization of the axon is frequent. The work of Howe, Tower and Duel (1937) has placed the phenomenon of associated movement following re-innervation on an anatomical basis, and the ultimate prognosis regarding the dissociated movement of the facial muscles is poor in view of this abnormal pattern of innervation. It may be possible, however, in some instances to improve the degree of recovery. Two cases of facial paralysis, in which there was complete axonal interruption, were followed through to functional recovery and their treatment carefully controlled. They were started on a daily session of "galvanism" and were also shown how to massage their faces, which they did a number of times daily. In addition, the angle of the mouth was kept elevated by means of a "facial" hook. Electromyographic recordings were made at weekly intervals and soon after the appearance of the first motor unit action potentials slight movement was observed on attempted voluntary contraction. The "galvanism" was then stopped and the patient began to practise individual facial movements in front of a mirror every day. The mode of regeneration and basis of associated movements were explained to the patients. In both instances, the patients were co-operative and in both cases associated movements were less than was usually seen.

Ballance and Duel (1932) have advocated that the facial nerve should be decompressed immediately a facial paralysis is seen in order to prevent axonal interruption, but, in view of the work of Denny-Brown and Brenner (1944*a* and *b*), it does not seem likely that many operations could be carried out in time to be effective. Furthermore, it is doubtful, from the anatomical point of view, whether exposure of the facial nerve from the lateral semicircular canal to the stylo-mastoid foramen and incising its sheath, is an adequate decompression. Kettel (1943) analysed a large number of cases of facial paralysis, associated with otitis media or mastoid infection, but came to no definite conclusion as to the optimum time for operation. He was, however, of the opinion that, in cases of immediate complete facial paralysis following mastoidectomy or labyrinthectomy, the facial nerve should be explored within seventy-two hours. In these cases, the operation of decompression seems to be of theoretical rather than practical value.

In one case of Bell's palsy, the paralysis persisted for six weeks but at no time was fibrillation, indicative of a lower motor neuron denervation, detected and recovery was complete and movements were normal. This is of interest for it suggests that the condition of a reversible ischæmic block may persist for very long periods.

There were three cases of very long-standing paralysis in which there was marked contracture. The contracture was confirmed as being due to fibrous metaplasia, for there were numerous areas of electrical "silence" in the facial muscles when electromyographic examinations were made. These patients had received no physiotherapy.

The intrinsic laryngeal musculature.—In order to record the action potentials from the intrinsic muscles of the larynx, it was necessary to use a concentric needle electrode of sufficient length so that all manipulations could be carried out through a laryngoscope.

The intrinsic muscles of the larynx have been investigated in a number of cases. The motor unit action potentials resemble those obtained from the facial musculature. The needle was first inserted into the lateral crico-arytenoid muscles and the subject requested to abduct the cords by taking a deep breath. There was continuous motor activity as long as the cords were abducted. When the cords were adducted, the motor unit activity decreased but did not die away completely. Thus the abductor muscles, even when the cords are adducted, maintain a certain amount of "tone".

Electromyographic examination has been found to be of value in cases of "idiopathic laryngeal palsy". In a few of these cases, normal motor unit activity was obtained from the muscles which were thought to be affected, and the immobility of the cords was shown to be due to ankylosis of the arytenoid cartilage. A certain degree of recovery in these cases is possible by re-education. Vocal cord paralysis as a result of denervation of the intrinsic laryngeal muscles was diagnosed by the presence of fibrillation action potentials. In these cases, recovery was not so good although it was possible at times to pick up polyphasic motor unit action potentials indicative of re-innervation.

REFERENCES

- BALLANCE, C., and DUEL, A. B. (1932) *Arch. Otolaryng.*, **15**, 1.
 DENNY-BROWN, D., and BRENNER, C. (1944a) *Arch. Neurol. Psychiat.*, **51**, 1.
 ——— (1944b) *Arch. Neurol. Psychiat.*, **52**, 1.
 HOWE, A., TOWER, S. S., and DUEL, A. B. (1937) *Arch. Neurol. Psychiat.*, **38**, 1190.
 KETTEL, K. (1943) *Arch. Otolaryng.*, **37**, 303.
 TURNER, J. W. A. (1944) *Lancet* (1), 756.
 WEDDELL, G., FEINSTEIN, B., and PATTLE, R. E. (1944) *Brain*, **67**, 178.

R. G. Macbeth described electromyography of the laryngeal muscles, first giving the technique and then proceeding to some illustrative cases. The patient was premedicated and prepared with surface anæsthesia as for any direct laryngoscopy, and the larynx was examined by the ordinary routine. Any diagnostic laryngoscopy might be employed. Usually the crico-arytenoideus lateralis muscle was initially explored, on the unaffected side first and then on the affected side. Then the posticus muscles were similarly explored. The lateralis muscle was reached by inserting the bipolar electrode through the aryepiglottic fold lateral to the cord. The posticus muscle was reached by passing the beak of the laryngoscope behind the arytenoids to each side of the mid-line in turn and inserting the electrode 1 to 2 cm. below the level towards the back of the cricoid cartilage. The patient was instructed to phonate or breathe deeply as required. By this technique doubtful cases of paralysis, crico-arytenoid fixation, and hysterical aphonia might be diagnosed with reasonable certainty. No untoward effects of the examination, except slight soreness, had been noted to date.

Mr. Macbeth then mentioned three illustrative cases:

(1) A lieutenant in the U.S. Army Air Corps was hit in the neck by a piece of flak. This had entered anteriorly on the right side and come to rest in the posterior muscles. He had become hoarse immediately after being struck, and remained so. Laryngoscopy showed the right cord immobile in the cadaveric position. Electromyography one month later revealed complete axonal interruption of the recurrent nerve on that side.

(2) A sergeant in the same Corps was hit in the neck near the larynx on the right side by flak. There was a history of considerable swelling in the region of the thyroid cartilage, which had subsided, and of hoarseness, which had persisted. Laryngoscopy two months later showed the right cord fixed in abduction and some thickening of the aryteno-epiglottic fold. Electromyography showed intact innervation on the affected side. Crico-arytenoid ankylosis, already suspected clinically, was thus confirmed.

(3) A Guardsman was undergoing preliminary training when he fell upon a tree-trunk and badly bruised the right side of his neck. There was considerable swelling, which subsided, and hoarseness, which persisted for six months. He had been discharged from the Army with a diagnosis of recurrent laryngeal nerve paralysis, after having been examined by a number of otolaryngologists. When seen in civilian life the right cord was in the cadaveric position and nothing else was to be made out clinically. X-rays of the laryngeal cartilage showed no fracture. Electromyography of the laryngeal musculature showed full motor activity on the affected side. His discharge diagnosis was thus disproved, and it became clear that he had a fixation of the crico-arytenoid joint.

A New Œsophagoscope

Martin Henry said that the distally illuminated œsophagoscope of the tubular type gave admirable illumination at the position where it was most needed, but it was difficult to manipulate, and being necessarily of the tubular pattern the field of view was restricted. The disadvantage of the proximally illuminated type of instrument was that, while giving an admirable open field at the end of the scope, it had diminished illumination.

He had designed an œsophagoscope which gave an open field of view at the distal end, was easy to manipulate, and afforded adequate illumination. A definite improvement in the illumination of proximally illuminated instruments could be obtained by aligning the lamps so that they bore directly on the distal end of the instrument. Existing instruments carrying their lights in long tubes were focused on the walls of the main tube, the illumination finally reaching the tip of the œsophagoscope by means of cross reflection, so that a proportion of the illuminating power of each bulb was lost. In his instrument the lamp-carrying tubes, instead of being some inches long, were only just long enough to prevent reflection from the bulb reaching the surgeon's eye. In this instrument the lamp-carrying tubes were inside the œsophagoscope. If the instrument was examined without the lamp-carrying saddle in it it would be noted that whether