LETTER TO THE EDITOR

Response to: Diagnostic accuracy of common clinical tests for assessing abdominal muscle function after motor-complete spinal cord injury above T6

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Bjerkefors *et al.*¹ have carried out a study on the role of the abdominal muscles below the level of a complete cord transection. This has long proved a source of mystery, so much so that as they point out, there is no established clinical method for examining motor function in the abdominal muscles following a spinal cord transection. Paradoxically, clinically it has been observed that these muscles appear to have some function and activity but what is the nature of this and how is it elicited? Bjerkefors *et al.* have endeavoured to answer this question.

The aim is to determine whether the muscle responses are voluntary and not simply a global activity that could be attributed to changes in intra-abdominal pressure, spasticity or stretch reflexes. They have endeavoured to rule out increases in intra-abdominal pressure as a main factor in activating this apparent contraction by studying electromyography (EMG) activity in 13 patients with cervical cord transections. Eleven patients had complete lesions but two had incomplete lesions of the spinal cord. They used surface electrodes but there was no recording of the ventilatory activity or recordings of the diaphragm or intra-abdominal pressure. They studied the patients with an open glottis and they say that the mechanism of this activation is unknown. They speculated that it was due to preservation of the cortico-spinal tract and that all the lesions were thus incomplete.

More than 50 years ago, stimulated and supervised by EJM Campbell whose work on the respiratory muscles is still the seminal work in this field, I used the equipment that he used to study the activity of the intercostals and abdominal muscles in 19 patients with complete cord transections between C4 and C8.² I used surface electrodes and in a small number of patients the activity was checked with a needle electrode and a Medelec oscilloscope. I found that there was respiratory reflex activity in the abdominal muscles that coincided with the inspiratory activity of both the sternomastoid and the third and fifth intercostals spaces.

The respiratory response of the abdominal muscles also coincided with the inspiratory activity of the sternomastoid muscle. Maximal and sustained expiration revealed no activity of the abdominal muscles, a finding that is in contrast to the normal expiratory response of abdominal muscles. I concluded that this activity was due to the normally innervated diaphragm contracting and pushing down on the abdominal viscera, which in turn caused a stretch reflex in the paralysed abdominal muscles. This was in complete contrast to the activity in normal people where the abdominal muscles are active during expiration.

Conversely, it was found that stimuli other than deep breathing such as plantar stimulation, manipulation of the lower limbs or

insertion of the urethral catheter could evoke reflex responses of the intercostals and abdominal muscles.

To localise this activity and to prove that it was not radiating through from the diaphragm, the method was refined by the use of wire electrodes and the use of an oesophageal electrode.³ This methodology was employed to study the activity of the abdominal muscles in eight stable complete tetraplegic patients.⁴ In all eight patients, we demonstrated phasic inspiratory EMG activity which we have shown to be localised to the abdominal muscles. We believed that the EMG activity, which we detected, was due to a stretch reflex mediated at the spinal level. The stimulus is stretching of the abdominal wall that activates abdominal muscle spindles and results in muscular contraction. In practice, we observed that the presence and amplitude of the phasic inspiratory activity relates to the degree and rate of abdominal wall distension. Some patients noted that a rapid deep inspiration induced spasms within their abdominal muscles and we demonstrated that this is initiated by the inspiratory EMG activity.

In this respect, it was interesting to find that once the reflex mechanism of the isolated cord has been fully developed, an afferent impulse as distant as that produced by plantar stimulation of the sole of the foot may elicit contractions in the intercostals and abdominal muscles. I would urge Bjerkefors *et al.* to extend their studies and correlate the activity of the muscles that they have determined with wire electrodes, ventilation, intra-abdominal pressure and monitoring the diaphragm by the use of an intra-oesophageal electrode.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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1 Bjerkefors A, Squair JW, Malik R, Lam T, Chen Z, Carpenter MG. Diagnostic accuracy of common clinical tests for assessing abdominal muscle function after motor-complete spinal cord injury above T6. *Spinal Cord* 2015; **53**: 114–119.

2 Guttmann L, Silver JR. Electromyographic studies on reflex activity of the intercostals and abdominal muscles in cervical cord lesions. *Paraplegia* 1965; **3**: 1–22.

3 Silver JR, Lehr RP. Electromyographic investigation of the diaphragm and intercostals muscles in tetraplegics. *J Neurol Neurosurg Psychiatry* 1981; **44**: 837–842.

4 Goldman JM, Silver JR. An electromyographic study of the abdominal muscles of tetraplegic patients. *Paraplegia* 1986; **24**: 241–246.