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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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We would like to thank Professor Silver for his interest[1] in our recent article[2] on preserved abdominal muscle activity in individuals with spinal cord injury (SCI) above T6. Given his prior work on recording indwelling electromyography during ventilatory activation of the diaphragm and abdominal muscles in participants with complete SCI, Professor Silver argues that our current results may be confounded by spinally mediated activation of the abdominal musculature due to the inspiratory activity of the diaphragm and changing intra-abdominal pressure. We agree that this is an important issue, which is why we implemented a number of procedural steps to control for this potentially confounding effect. First, we standardized the breathing pattern by always having participants attempt maximal contractions during a 2-s period of normal expiration, performed with an open glottis. Performing a controlled expiration should decrease intra-abdominal pressure and relax the diaphragm[3] throughout the period of attempted abdominal muscle contraction, thus minimizing the likelihood of eliciting passive stretch reflexes in the abdominal muscles. Second, we asked participants to perform trunk movements that are known to require direction-specific patterns of abdominal muscle activity.[4] The abdominal muscle activity we observed in most participants with SCI was indeed task and direction specific, which is contrary to the more global pattern of bilateral abdominal muscle activity that would be expected from stretch reflexes elicited by ventilatory activity in other muscles such as the diaphragm. Third, our observations are supported by other recent work that identified preserved abdominal muscle function in individuals with motor-complete SCI above T6 in response to transcranial magnetic stimulation (TMS).[4] In this study, participants with motor-complete SCI above T6 showed motor-evoked potential (MEP) responses to TMS in the abdominal muscles with onset latencies that were similar to controls. MEPs recorded from the diaphragm using surface electrodes were found to precede abdominal muscle MEPs by an average of 2 ms, which is too short to be explained by passive stretching of the abdominal muscles following the MEP in the diaphragm. Furthermore, the absolute latencies of MEPs that were recorded in the abdominal muscles in participants with SCI (19.3–24.0 ms) were too short to be explained by a stretch reflex, which have been shown to have minimum latencies of 15–22 ms,[5] and would be in addition to the time needed to initially activate the diaphragm and increase intra-abdominal pressure to the extent that it would stretch the abdominal muscles sufficiently to elicit a reflex.

With these safeguards in place, we are confident that our observations of preserved voluntary activity in abdominal muscles in participants with motor-complete SCI above T6 are not simply the result of spinally mediated activation of the abdominal musculature due to the inspiratory activity of the diaphragm and increased intra-abdominal pressure. However, we agree with Professor Silver that subsequent studies should incorporate indwelling electrodes, intra-abdominal pressure measures and possibly TMS to provide further insight into the potential mechanisms that may contribute to the observed abdominal muscle activity in individuals with motor-complete SCI.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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