



Letter to the Editor

Motor unit number index (MUNIX) and compound muscle action potential amplitude: A reappraisal



We have read with interest the report by Bostock and colleagues (Bostock et al., 2019) where they analyzed the relationship between the motor unit number index (MUNIX), surface EMG interference pattern (SIP) and the compound muscle action potential (CMAP) amplitude using a theoretical model they developed. In the “Highlights” section of their study they state “MUNIX is almost entirely dependent on the CMAP amplitude in healthy controls and patients. MUNIX should not be used as a measure of the number of functional motor units in a muscle”. The “Results” section of abstract states that MUNIX “is insensitive to changes in SIP amplitude”. In the final paragraph of their discussion, they attribute this to “motor unit potential overlap” in the SIP. These conclusions derived from their theoretical model are at odds with our previous experimental recordings (Nandedkar et al., 2010). We will refute them using our recent experimental recordings.

We present findings in the abductor pollicis brevis (or thenar) muscle of 22 patients with amyotrophic lateral sclerosis (ALS) (probable or definite) from last the two years, made using the automated MUNIX program according to published guidelines (Nandedkar et al., 2018). Studies were approved by the local institutional review board, and subjects gave written informed consent. Fig. 1A shows a plot of motor unit size index (MUSIX) against the CMAP amplitude. The vertical dotted line shows the lower limit of CMAP amplitude, while the horizontal dotted line shows the upper limit of MUSIX. MUSIX is calculated as

$$\text{MUSIX} = \text{CMAP Amplitude} / \text{MUNIX}$$

If MUNIX “almost entirely depended on the CMAP”, their ratio (i.e. MUSIX) must be relatively constant in all studies. Yet ALS patient data shows significant increase in MUSIX when CMAP amplitude is normal and also when it is reduced (all data points above the horizontal line in Fig. 1A). Clearly MUNIX does not depend on CMAP amplitude alone.

MUNIX is also affected by the SIP signals. Fig. 1B shows SIP recordings at slight effort in a control subject (top two traces) and an ALS patient (bottom two traces). Their SIP signals are quite different although the CMAP amplitude in these subjects was normal, and practically the same (9 mV and 9.1 mV). The ‘ideal case

motor unit count (ICMUC)’ values are smaller for the patient, resulting in lower MUNIX. In this example the loss of motor units (reduced MUNIX) was compensated by reinnervation (increased MUSIX) giving a normal CMAP. If MUNIX was “insensitive to SIP amplitude” we would have seen similar MUNIX values for the two subjects in Fig. 1. SIP does affect MUNIX and MUSIX.

In the final paragraph of their discussion Bostock and co-workers (Bostock et al., 2019) indicate ‘overlap of motor unit potentials’ in SIP makes MUNIX dependent upon CMAP amplitude. This is at variance from our approach to SIP recording (Nandedkar et al., 2018). We record about one third of SIP signals at minimal voluntary effort where MUP superimposition is minimal (see traces in Fig. 1B) and SIP area is low (less than 100 mVms) (Fig. 1B). This is a critical component of the MUNIX technique as we monitor the SIP area during recordings.

The implication of their model was that “MUNIX should not be interpreted as a motor unit number estimation (MUNE) method”. They suggest that MUNE methods are more accurate than MUNIX. All MUNE values reflect the assumptions made in their respective methods, their recording techniques, etc. Hence the results of MUNE values for a given muscle differ significantly between methods (Stålberg et al., 2019). They also differ from recently described anatomic data (Gesslbauer et al., 2017). Therefore, we believe that all methods, including ours, are an “index”. Whether we call it an estimate versus an index is a matter of personal preference, and does not imply the “accuracy” of results.

From a practical view point, it takes us less than 5 minutes to perform a MUNIX study including skin preparation, electrode application, recordings, analysis, and review. SIP recordings with artifacts can be seen and removed while performing the examination. The results are available on-line. The study is well tolerated by patients. As demonstrated above and in previous studies the results do show changes in the number of motor units that correlates with their clinical course (Nandedkar et al., 2010). We will continue to use MUNIX for our research studies and in routine.

Declaration of Competing Interest

The first author is an employee of Natus Neurology. This work represents no conflict. The second and third authors have no conflict to report.

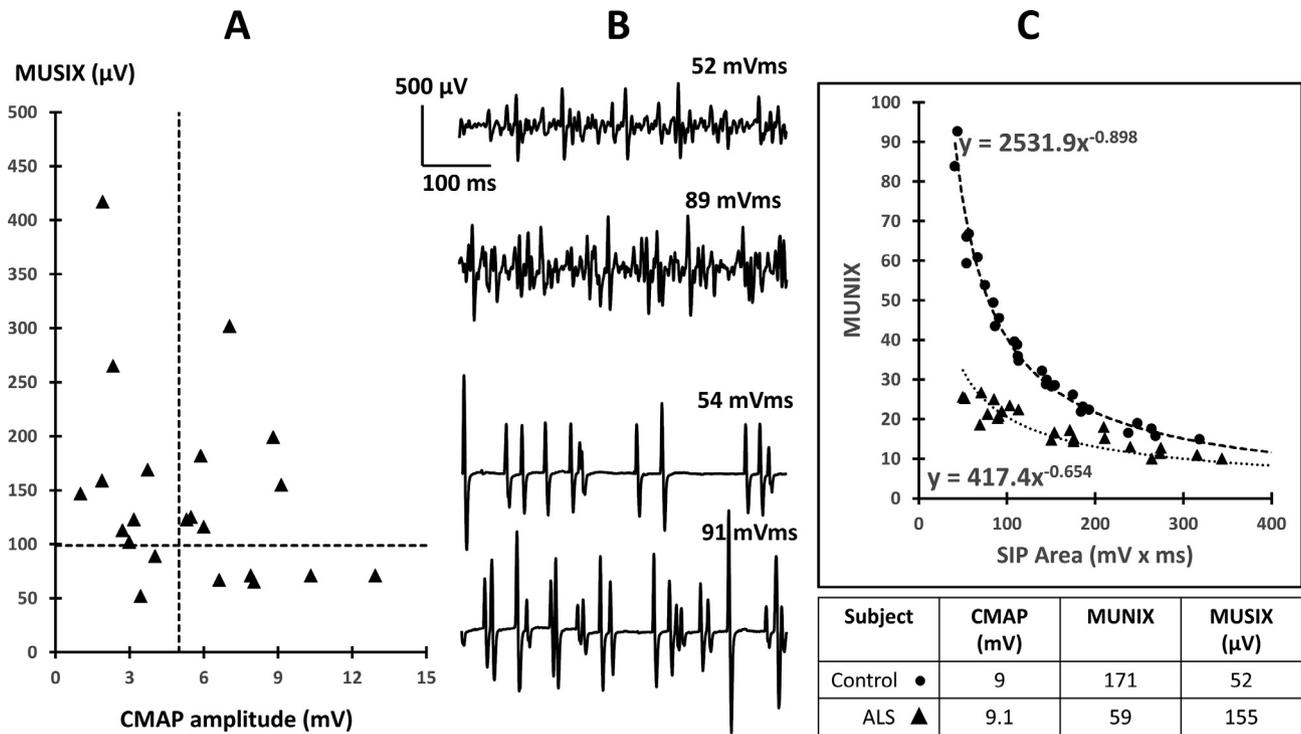


Fig. 1. MUNIX studies from ALS patients. (A) MUSIX is increased (above the dotted horizontal line) in patients with normal and reduced amplitude CMAP. Vertical dotted line separates data with normal and reduced CMAP. (B) SIP waveforms with low area in a control subject (top two traces) are shown at the top. The bottom two traces recorded from an ALS patient have similar area but very different waveforms. Area values are shown above each trace. The baseline is seen easily in the ALS patient. In the control subject, the motor unit potentials were separated by baseline, but this is not seen due to slow sweep setting. When recording, we observe the SIP signals at 10 ms/div setting. (C) ICMUC values are quite different for control subject (filled circle) and ALS patient (filled triangles), though they had the same CMAP amplitude. The tabulated data show markedly different values for MUNIX and MUSIX.

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