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Letter to the Editor

Conduction studies on the sural nerve

Some of the most influential studies of sensory conduction in lower limb nerves were undertaken by Buchthal's group in Copenhagen, using near-nerve needle electrodes and signal averaging (e.g., Behse and Buchthal, 1971, 1978; Horowitz and Krarup, 1992). However few laboratories now rely on invasive near-nerve needle recordings. To my knowledge, the first conduction study on the sural nerve using surface electrodes was by Di Benedetto (1970), predating Buchthal's 1971 paper, and the next reports using these less-invasive techniques were by Di Benedetto (1972) and Burke et al. (1974). The studied nerve segment in most laboratories has been the calf-lateral malleolus segment but, in a recent issue of *Clinical Neurophysiology Practice*, Krøigård and colleagues (Krøigård et al., 2021) document conduction for the more distal lateral malleolus-5th metatarsal segment, along the "dorsal sural nerve". In an important paper, they present normative values for conduction along this nerve segment in a large cohort (n = 229, aged 21–80 years). While the study is on healthy control subjects, its focus is on the value of these studies in the screening for polyneuropathy, a usage with which I fully agree. In addition, dorsal sural studies may also be of value as a control for an abnormal sensory study on the hallux-ankle segment of the posterior tibial nerve in conditions such as tarsal tunnel syndrome.

The report by Krøigård and colleagues (Krøigård et al., 2021) recalled a personal study some 37 years ago (Burke et al., 1974), in which sural conduction was recorded over "the proximal segment" (i.e., calf-lateral malleolus) and "the distal segment" (i.e., lateral malleolus-5th metatarsal, along the dorsal sural nerve, the segment studied by Krøigård and colleagues). This was in the days before signal averaging became routine, the smallest sensory nerve action potential (SNAP) that could be identified in a sequence of single sweeps for the distal segment was 1.5 μV, and the SNAP could not be defined in 7 of 72 controls subjects. Krøigård and colleagues could record the SNAP for the dorsal sural nerve in all 229 healthy subjects, but reference to their Fig. 3A,C suggests that, when at least 20 sweeps were averaged, the smallest definable SNAP was approximately 1.0 μV.

Burke et al. (1974) compared sural and median studies in 300 patients suspected of suffering from polyneuropathy, and not surprisingly found sural studies superior. However in 98 patients they recorded the SNAP for the proximal and distal segments of the sural nerve. In agreement with the sentiments of Krøigård and colleagues (Krøigård et al., 2021), they found that "*a distal sural SAP has not been recorded when the proximal sural SAP could not be distinguished, was of lower than normal amplitude, or was conducted with abnormally slow velocity – that is, when there has been abnormality of sensory conduction in the proximal segment of the sural nerve, a SAP has not been recordable in the distal segment despite painstaking effort.*" The conclusion that studies of the distal segment, i.e., the dorsal sural nerve, add value in diagnosing polyneuropathy has been supported by Killian and Foreman (2001) and subsequent authors.

Another finding in the 79 controls in the study of Burke et al. (1974) was that the amplitudes of both the median SNAP and the sural SNAP declined significantly with age, and so too did their conduction velocities. However the change in the conduction velocity of the median SNAP was prominent while that of the sural SNAP was quite modest. None of the subjects had clinical evidence of peripheral nerve disease, particularly carpal tunnel syndrome, and the discrepancy in the age-related changes in conduction velocity was attributed to subclinical wear-and-tear on the median nerve with flexion–extension movements of the wrist during normal life. It is therefore of interest that, by measuring the movement of a microelectrode inserted into the median nerve, McLellan and Swash (1976) estimated that the nerve moves millimetres back and forth across the wrist with active and passive movements of the wrist (10–15 mm with hyperextension) – "sliding" occurred even with more proximal movements not involving the wrist. "*The fact that entrapment neuropathies are common in those who use their limbs for repetitive tasks over prolonged periods (Spaans, 1970) suggests that to-and-fro sliding across a site of potential entrapment might cause focal perineural damage leading to a restriction of sliding at that point*" (McLellan and Swash, 1976).

There are areas where some caution should be retained with both papers. Burke et al. (1974) did not measure temperature routinely, but temperature control is important, particularly when conduction velocities are borderline. They wrote: "*The studies were carried out in an air-conditioned room at constant temperature. No systematic recording of limb temperature was made, skin temperature being determined in only some subjects. As a routine, where a limb felt cool it was warmed by immersion in warm to hot water.*" In the study by Krøigård and colleagues (Krøigård et al., 2021), "*Cursors were set automatically if the sensory potential was identified by the Keypoint. Net EMG equipment. Otherwise, they were set manually.*" Computerised measurement of the onset latency of the SNAP can introduce errors when the potential is small and the initial positive deflection cannot be recognised by the algorithm. In the example in their Fig. 2 the onset latency is correctly recognised as a change in direction of the waveform at the positive peak. However when the initial positivity is too small to be recognised, the algorithm then indicates when the negative phase deviates significantly from

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baseline. Of necessity this must occur after the onset of the negativity and, accordingly, the onset latency is overestimated. As stated elsewhere (Tankisi et al., 2020), "*In digital EMG machines automatic cursor placement algorithms are available. While these are very useful and provide standardization for measurements and usually high accuracy, it is mandatory to inspect visually the accuracy of cursor placement*."

Declaration of Competing Interests

The author has no competing financial interests or personal relationships that could have influenced the work reported in this paper.

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