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Editorial

Clinical and economic arguments to support a neuromuscular ultrasound service

Neuromuscular ultrasound (NMUS) is no longer an emerging diagnostic modality. Rather, it is an established and core component of modern neuromuscular medicine. It is likely that many neuromuscular physicians and clinical neurophysiologists have already considered how to incorporate NMUS into their clinical practice. There are some barriers to establishing a NMUS practice as part of a neurology or neurophysiology department. The key ones are equipment costs, theoretical and technical knowledge deficits, and access to sufficient, quality practical experience. Below is a summary of the arguments in favor of incorporating NMUS into all major neurology departments; the resources presently available; and, possible solutions to the residual hurdles preventing universal deployment of the technique.

There has been an exponential increase in the number of publications investigating the use of NMUS. As such there is a robust scientific basis for the use of NMUS in a number of clinical scenarios. In the current issue of Clinical Neurophysiology Practice, Doctors Gonzalez and Hobson-Webb comprehensively review the scientific literature and provide detailed descriptions of the NMUS findings in peripheral nerve and muscle disease (Gonzalez and Hobson-Webb, 2019). In summary, nerve ultrasound has a confirmed role in the work up of compressive mononeuropathy. Nerve ultrasound provides valuable supplementary information in the work-up of some types of peripheral neuropathy, in particular inflammatory and hereditary demyelinating neuropathies. Muscle ultrasound can support a diagnosis of muscle disease including by documenting characteristic patterns of muscle involvement and guiding the selection of a muscle biopsy site, and quantitative muscle ultrasound may be of value to monitor the progression of muscle changes in progressive myopathies. From a treatment perspective, ultrasound is now ubiquitously used in procedures such as peripheral nerve blocks.

There are a number of specific clinical scenarios where routine access to NMUS in the neuromuscular clinic makes a major difference to patient care. In compressive mononeuropathy, nerve ultrasound should be routine in any patient presenting with unilateral carpal tunnel syndrome (both on clinical and electrodiagnostic assessment) due to the relatively high detection rate of ganglion cysts contributing to nerve compression (Cartwright et al., 2012; Nakamichi and Tachibana, 1993). Further, nerve ultrasound should be mandatory for patients presenting with ulnar neuropathy at the elbow (UNE) or fibular neuropathy at the fibular head. In the case of UNE, identifying focal nerve strictures will confirm that the mechanism of nerve injury is entrapment and hence respond to surgical decompression rather than due to extrinsic compression or traction which may not (Omejec and Podnar, 2018; Simon, 2018). Finally, nerve ultrasound should be performed in all patients presenting with fibular neuropathy to confirm the relatively uncommon occurrence of entrapment of the nerve in the fibular tunnel or the possibility of intraneural ganglion cysts, both of which will significantly change treatment approaches (Lo et al., 2007; Stewart, 2008).

Besides the implication for management decisions, NMUS substantially enhances existing diagnostic algorithms. For example, detection of fasciculations has been elevated to a prime indicator of lower motor neuron involvement in the work up of amyotrophic lateral sclerosis (ALS) (de Carvalho et al., 2008). Dynamic muscle ultrasound is the most sensitive modality for the detection of fasciculations in ALS and improves the certainty of diagnosis (Misawa et al., 2011; Noto et al., 2018). As such, dynamic muscle ultrasound should be considered a standard investigation in the diagnostic work up of ALS, particularly when the presentation is atypical.

Diaphragm weakness is another situation where ultrasound may disrupt existing diagnostic strategies. Patients with diaphragmatic weakness observed on respiratory function testing were traditionally referred for neurophysiological studies when a neuromuscular cause was suspected. However, phrenic nerve conduction studies can be unreliable and sensitive to a patient's habitus. Diaphragm electromyography (EMG) carries a risk of pneumothorax, and may be contraindicated where there is critical respiratory insufficiency. Diaphragm ultrasound is easy to perform and demonstrates changes in the thickness of the diaphragm with inspiration and expiration. Ultrasound will demonstrate acute or chronic neuromuscular diaphragm weakness with findings correlating with respiratory function test parameters (Pinto et al., 2016). Although diaphragm ultrasound does not show whether chronic neuromuscular weakness is on a neurogenic or myopathic basis, subsequent EMG can be guided by ultrasound, either with direct needle visualization, or measurement of the depth and thickness of the diaphragm prior to EMG to enhance safety (Boon et al., 2008).

From a financial perspective, the initial barrier to the development of a NMUS practice is often the cost of the ultrasound unit. With developments in technology, even relatively inexpensive laptop based systems provide sufficient image quality to study most of the commonly injured limb nerves and most muscles.

There are strong financial arguments for incorporating NMUS capabilities in all neurophysiology laboratories. The addition of

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NMUS to electrodiagnostic studies improves self-reported quality of life outcomes in patients with focal neuropathies (Cartwright et al., 2015). Importantly, cost-effectiveness analyses have demonstrated only a modest cost for each extra quality-adjusted life year (QALY) gained by the use of diagnostic ultrasound in the work up of focal neuropathies. Specifically, the addition of ultrasound to electrodiagnostic studies for the work up of focal neuropathies costs $USD463 per QALY gained (Mandeville et al., 2019). This compares favorably to intravenous immunoglobulin for chronic inflammatory demyelinating polyneuropathy which costs $USD687287 per QALY gained (Blackhouse et al., 2010). The cost-effectiveness of ultrasound for the diagnosis of other neuromuscular disorders has not yet been established. However, it is clear that the initial equipment costs can be justified on the basis of enhancement in patient care.

A further issue faced by those clinicians intending to pursue NMUS in the neuromuscular or neurophysiology clinic is the requirement to develop a specific technical and theoretical knowledge base. Presently much of the training in NMUS is on an apprenticeship basis, with skills acquired in the clinic through practice supervised by a trained mentor. This apprenticeship model is often supplemented by brief NMUS courses. The availability of courses and mentors varies by geographical region, which can limit training opportunities. While formal training in musculoskeletal sonography may be ideal, often requiring two years of full time study to complete, this may not be required if ultrasound practice is limited to neuromuscular applications and complementary to electrodiagnostic assessment. However, there remain medicolegal issues if a NMUS study reveals a pathology that is either missed or misreported, particularly when involving tissues beyond muscle and nerve structures. For this reason it is suggested that NMUS reports specify that detailed analysis was restricted to nerve and muscle structures and any atypical or non-neuromuscular findings are referred for further imaging studies or reassessed in collaboration with a musculoskeletal radiologist.

The American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) has developed guidelines for the skills required to perform and interpret NMUS which serve to guide training in the field (Walker et al., 2014). Essentially, these are the skills needed to perform and interpret electrodiagnostic studies such as understanding peripheral nerve and muscle anatomy, neuromuscular disease patterns and diagnostic and management implications of abnormal findings. In addition, AANEM require knowledge of ultrasound equipment functions, ultrasound techniques and common artifacts as well as the characteristic changes on ultrasound in healthy and abnormal nerve and muscle. Neurology and clinical neurophysiology associations worldwide should adopt processes to accredit NMUS as a supplement to existing professional certifications, and to designate neuromuscular centres and practitioners as accredited training sites and mentors respectively. To do this, association-sanctioned training courses and formalized assessment procedures need to be developed.

Declaration of Competing Interest

Dr Simon reports no conflicts of interest.

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