Critical Care Neuropathy Associated with COVID-19

Timothy J. Olivier, MD, Faren Williams, MD, MS

Department of Orthopedics and Physical Rehabilitation, University of Massachusetts Medical School

BACKGROUND

- Neuromuscular disorders, predominantly critical illness myopathy (CIM) and critical illness polyneuropathy (CIP) occur in ~1/3 patients in ICUs
- The mechanism of injury in CIP is unknown, possibly related to injury to the microcirculation of distal nerves
- CIP is associated with sepsis and difficulty weaning from mechanical ventilation

CASE DESCRIPTION

PRESENTATION:

- 60 y/o male presented with profound weakness in R > L hands and numbness in his fingertips.
- past medical history: type 2 diabetes and polyneuropathy in his feet, hypertension, peripheral vascular disease, and osteoarthritis
  - Fingertip numbness unlike that in toes
- previously diagnosed with COVID-19 and hospitalized for 2 months, ICU, with intubation, trach, and PEG tube placement
- Physical exam: duputren's contractures L > R, decreased distal sensation (hands > feet, R > L), generalized distal hand muscle atrophy, L > R, gait without focal abnormalities.

EVALUATION:

- **Nerve Conduction Studies:**
- significant sensory neuropathy, in the lower and upper extremities, with L > R decreased ulnar motor amplitude, and conduction block. Focal slowing across the carpal ligament on the L (consistent with CTS) and no R median sensory
- **Needle EMG:**
- decreased recruitment on needle EMG in ulnar innervated muscles. No spontaneous activity

EMG/NCS

Stim Site	NR	Onset (ms)	Peak (ms)	P-T Amp (uV)	Dist (cm)	Vel (m/s)
Left Median Mid Palm Index Anti Sensory (Index)						
Wrist		3.8	4.7	3.8	7	28
Mid Palm		1.3	2.0	5.8	7	54
Right Median Palm Index Anti Sensory (Index)						
Wrist	NR				7	
Mid Palm	NR				7	
Right Sural Anti Sensory (Lat Mall)						
Calf		2.9	3.5	2.1	10	34
Left Ulnar Anti Sensory (Little Finger)						
Wrist	NR				14	
Right Ulnar Anti Sensory (Little Finger)						
Wrist		3.7	4.8	6.3	14	38

Side	Muscle	Nerve	Fibs	Psw	Amp	Dur	Poly	Recrt	Effort	CRD
Right	1stDorInt	Ulnar	0	0	Nml	Nml	0	Nml	Nml	0
Right	Abd Poll Brev	Median	0	0	Nml	Nml	0	Nml	Nml	0
Right	ABD Dig Min	Ulnar	0	0	Nml	Nml	0	Reduced	Nml	0
Right	ExtIndicis	Radial (Post Int)	0	0	Nml	Nml	0	Nml	Nml	0
Right	PronatorTeres	Median	0	0	Nml	Nml	0	Nml	Nml	0
Right	Biceps	Musculocut	0	0	Nml	Nml	0	Nml	Nml	0
Right	Triceps	Radial	0	0	Nml	Nml	0	Nml	Nml	0
Left	1stDorInt	Ulnar	0	0	Nml	Nml	0	Reduced	Nml	0
Left	Abd Poll Brev	Median	0	0	Nml	Nml	0	Nml	Nml	0
Left	ABD Dig Min	Ulnar	0	0	Nml	Nml	0	Discrete	Nml	0
Left	ExtIndicis	Radial (Post Int)	0	0	Nml	Nml	0	Nml	Nml	0
Left	PronatorTeres	Median	0	0	Nml	Nml	0	Nml	Nml	0
Left	Biceps	Musculocut	0	0	Nml	Nml	0	Nml	Nml	0
Left	Triceps	Radial	0	0	Nml	Nml	0	Nml	Nml	0

Diagnosis of Critical Illness Neuropathy

Table 3. Summary of electrodiagnostic features in CIM and CIP.

Disorder	CMAP	SNAP	Direct muscle stimulation	Spontaneous activity	Motor unit potentials
CIM*	Low amplitude; +/- long duration	Normal	Low dmCMAP; neCMAP to dmCMAP ratio of >0.5	Fibrillation potentials in > 70%; May be diffuse	Short duration, low amplitude with early full recruitment
CIP*	Low amplitude	Low amplitude or absent	neCMAP to dmCMAP ratio of <0.5	Fibrillation potentials in all; 30% diaphragm fibrillation potentials	Decreased recruitment; Evolving "neurogenic" morphology

**Absence of decremental response with repetitive stimulation and absence of conduction block or prolonged F-waves.*
dmCMAP, direct muscle stimulated CMAP.
neCMAP, nerve evoked CMAP.

Diagnostic criteria for critical illness polyneuropathy
Major features:
Critical illness (especially with sepsis, multiorgan failure, SIRS)
Difficulty weaning from ventilator not related to cardiopulmonary causes
Possible limb weakness
Electrophysiologic evidence of axonal motor and sensory polyneuropathy
Features favoring the diagnosis:
Sensory and motor nerve amplitudes <80% of lower limit of normal in ≥ 2 nerves on NCS
Absence of conduction block or prolongation of F waves
Needle EMG with reduced recruitment of normal MUPs (early) followed by fibrillation potentials and reduced recruitment of long-duration, high-amplitude MUPs (after weeks)
Absence of decremental response on repetitive nerve stim
Supportive features:
Normal CSF protein
Normal serum CK

"In survivors of CIP with mild or moderate nerve injury, recovery of muscle strength generally occurs over weeks to months."

CASE DIAGNOSIS

The patient's diabetes with HgA1C 6.1 was initially not thought to explain his symptoms and electrodiagnostic findings. They were thought to be more consistent with a critical care neuropathy. On follow up, it was revealed that patient's diabetes might have been more contributory than initially thought, with the disease process being primarily neuropathy rather than myopathy.

DISCUSSION

- A possible side effect of COVID 19 treatment involving long-term critical care is critical care neuropathy or myopathy.
- CIP/CIM has significant implications for recovery of prior function including ability to perform basic ADL's, and higher-level ones such as a job which in this case involved physical work.
- Time to therapy/rehabilitation is an important factor in return of function

CONCLUSIONS

- This case illustrates the rehabilitation and neuromuscular issues that can result from COVID 19 and is a reminder that physiatrists need to be astute diagnosticians, utilizing tools like electrodiagnosis, when evaluating one's potential for a complete, functional recovery.
- This holistic approach to patient care also includes management of the mobility impairments along with treatment of other concomitant problems such as neuropathic pain to improve the patient's quality of life.

References

1. https://www.uptodate.com/contents/neuromuscular-weakness-related-to-critical-illness?search=critical%20care%20neuropathy&sectionRank=2&usage_type=default&anchor=H3934991076&source=machineLearning&selectedTitle=1~150&display_rank=1#H3653537045
2. https://www.uptodate.com/contents/screening-for-diabetic-polyneuropathy?search=diabetic%20neuropathy%20symptoms&source=search_result&selectedTitle=2~150&usage_type=default&display_rank=2#H3
3. ELECTROPHYSIOLOGY OF NEUROMUSCULAR DISORDERS N CRITICAL ILLNESS
4. https://www.uptodate.com/contents/neuromuscular-weakness-related-to-critical-illness?search=polyneuropathy&topicRef=5284&source=see_link#H22
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5167093/
6. https://www.uptodate.com/contents/overview-of-polyneuropathy?search=polyneuropathy&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1#H6425345
7. https://www.uptodate.com/contents/neuromuscular-weakness-related-to-critical-illness?search=critical%20care%20neuropathy&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1#H3934991076