



Serial electrodiagnostic testing to evaluate nitrous oxide-induced peripheral neuropathy



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Introduction

Toxic effects of nitrous oxide (N<sub>2</sub>O) abuse are reported in the literature with clinical presentations of myeloneuropathy, subacute combined degeneration, mood changes, psychosis and even death. Few studies describe the electrodiagnostic (EDX) features that are related to N<sub>2</sub>O-induced neuropathy. This case expands on previously reported EDX findings and demonstrates the utility of serial EDX testing as a prognostic tool for N<sub>2</sub>O-induced neuropathy.

Case Description

A 23-year-old female presented with a 2-week history of bilateral lower extremity paraparesis, paresthesia, and progressive difficulty walking. Exam revealed bilateral foot drop, a wide-based gait and lower extremity areflexia with decreased temperature and vibratory sensation. Labs were significant for an elevated vitamin B12 level of 2944 (ref range 180-1241). Other work up including metabolic, infectious, MRI spine, and lumbar puncture were unremarkable.

The patient later admitted to a 2-year history of recreational N<sub>2</sub>O use, which caused occasional stocking-and-glove peripheral neuropathy that would self-resolve. She endorsed that 3 weeks prior to her presentation she engaged in a 4-day period of anorexia and heavy N<sub>2</sub>O use, approximately 1200 N<sub>2</sub>O canisters total. She self-diagnosed N<sub>2</sub>O toxicity and attempted to self-treat with oral vitamin B12. In the acute hospital, patient was treated with IM vitamin B12 1000 mcg/day for 7 days.

Rehabilitation

In acute inpatient rehabilitation, the patient had a stable bilateral foot drop with improvement in proximal lower extremity strength. A limited baseline EDX study demonstrated findings seen to the right in light blue. Upon discharge, she was a limited household ambulator with bilateral solid ankle-foot orthoses and a front-wheel walker.

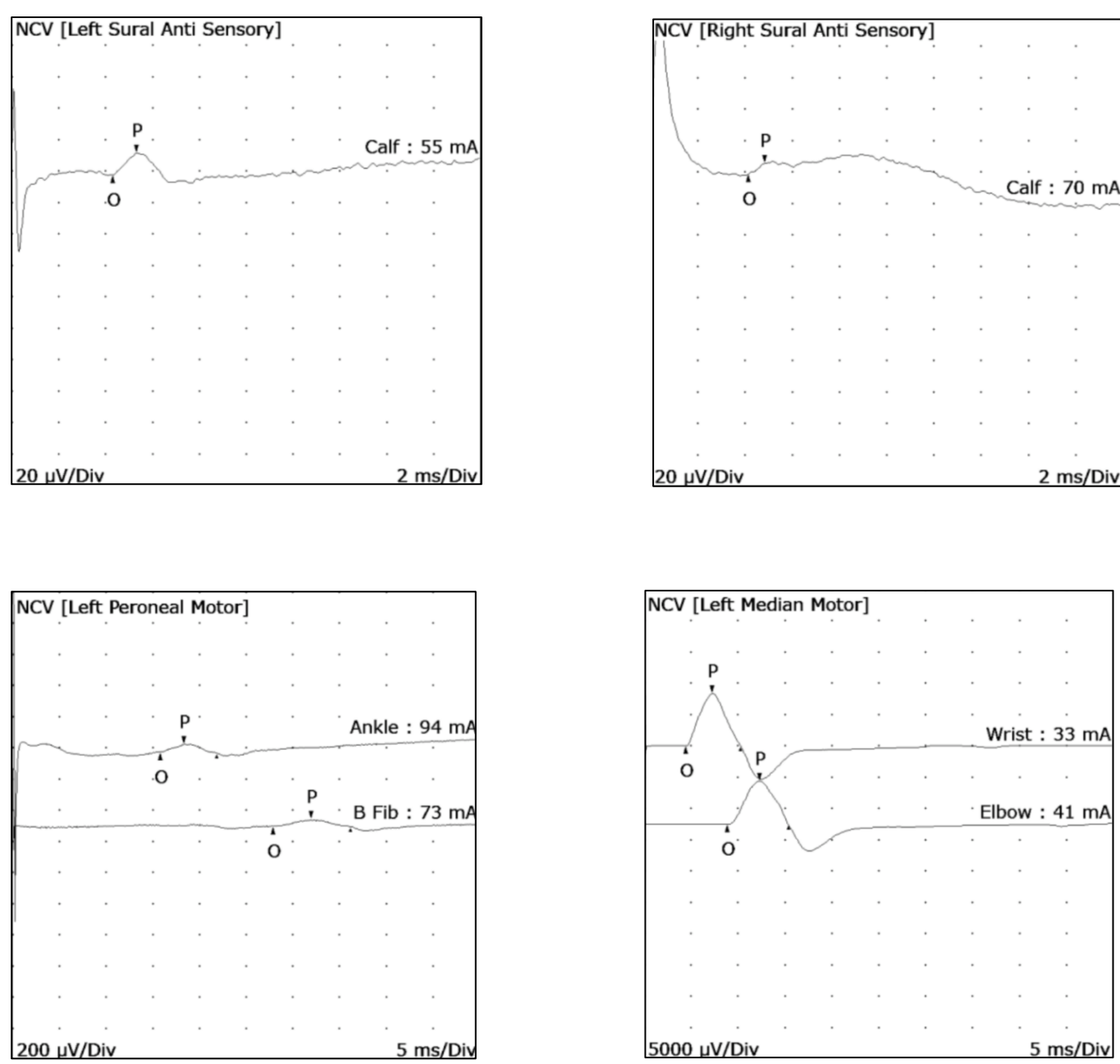
Electrodiagnostic Test Findings

| Sensory Summary Table (NCS)    |          |                |               |          |               |                |                |               |          |               |                |
|--------------------------------|----------|----------------|---------------|----------|---------------|----------------|----------------|---------------|----------|---------------|----------------|
|                                |          | Baseline EDX   |               |          |               |                | Follow Up EDX  |               |          |               |                |
| Nerve/ Site                    | Rec Site | Onset Lat (ms) | Peak Lat (ms) | Amp (µV) | Distance (mm) | Velocity (m/s) | Onset Lat (ms) | Peak Lat (ms) | Amp (µV) | Distance (mm) | Velocity (m/s) |
| L Ulnar – Digit V (Antidromic) |          |                |               |          |               |                |                |               |          |               |                |
| Wrist                          | Dig V    | 3.0            | 4.0           | 36.8     | 140           | 47             |                |               |          |               |                |
| R Sural – Ankle (Calf)         |          |                |               |          |               |                |                |               |          |               |                |
| Calf                           | Lat Mall | 4.2            | 4.8           | 7        | 140           | 33             | NR             | NR            | NR       | 140           | NR             |
| L Sural – Ankle (Calf)         |          |                |               |          |               |                |                |               |          |               |                |
| Calf                           | Lat Mall | 4.3            | 5.3           | 14.6     | 140           | 33             | 3.23           | 4.43          | 3.6      | 140           | 43             |

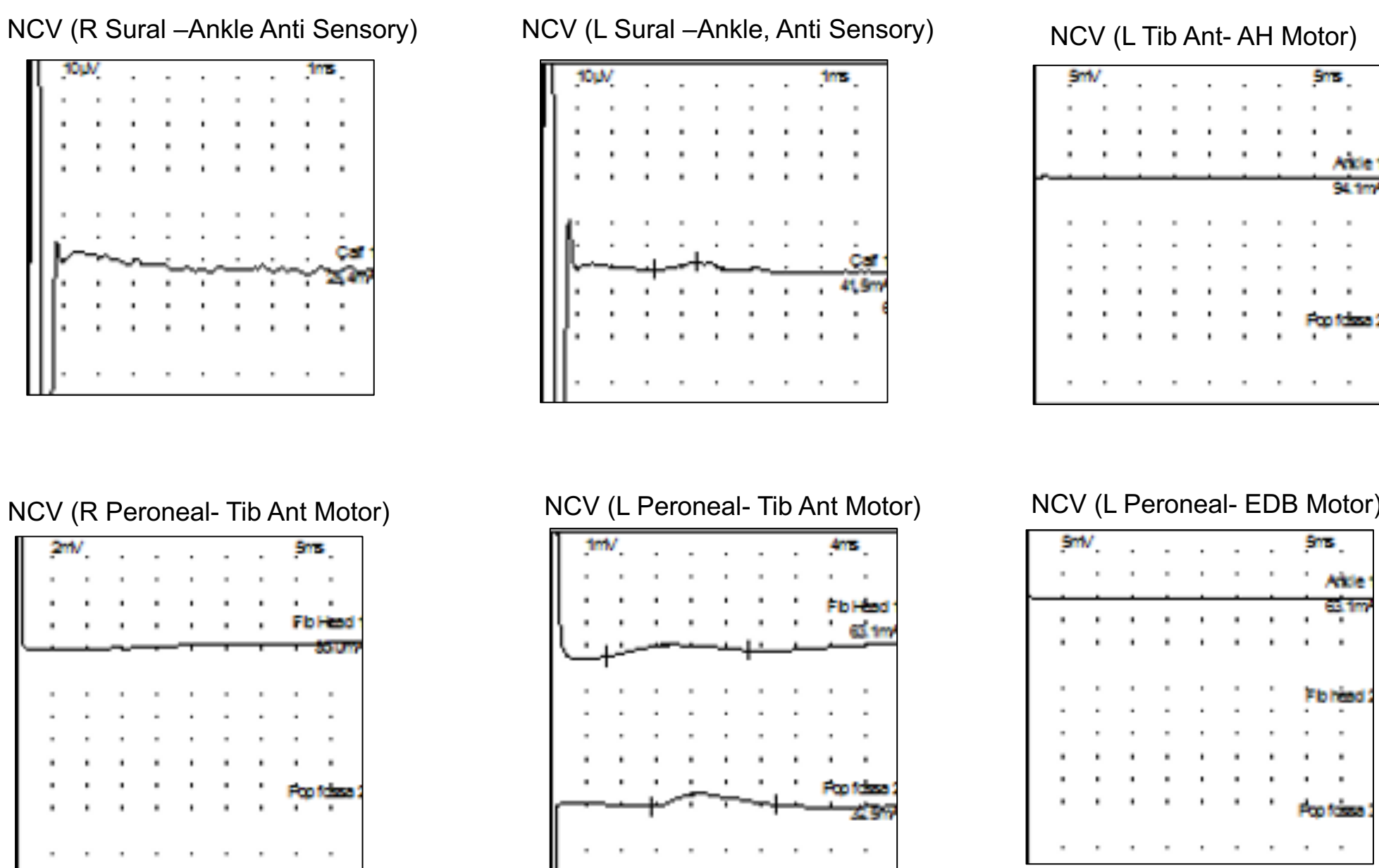
| Motor Summary Table (NCS) |                      |         |              |                |               |                      |                    |               |               |                |            |
|---------------------------|----------------------|---------|--------------|----------------|---------------|----------------------|--------------------|---------------|---------------|----------------|------------|
|                           | Nerve / Sites        | Muscle  | Latency (ms) | Amplitude (mV) | Duration (ms) | Area (mVms)          | Segments           | Distance (mm) | Lat Diff (ms) | Velocity (m/s) | Temp. (°C) |
| Baseline EDX              | L Median- APB        |         |              |                |               |                      |                    |               |               |                |            |
|                           | Wrist                | APB     | 4.5          | 8.4            | 5.86          | 26.30                | Wrist - APB        | 225           | 4.4           | 5.1            |            |
|                           | Elbow                | APB     | 8.9          | 7.0            | 6.48          | 24.56                | Elbow - Wrist      |               |               |                |            |
|                           | L Peroneal - EDB     |         |              |                |               |                      |                    |               |               |                |            |
|                           | Ankle                | EDB     | 15.9         | 0.1            | 6.02          | 0.16                 | Ankle- EDB         | 275           | 12.0          | 23             |            |
| Follow Up EDX             | B. Fib               | EDB     | 27.9         | 0.0            | 8.28          | 0.21                 |                    |               |               |                |            |
|                           | R Peroneal - EDB     |         |              |                |               |                      |                    |               |               |                |            |
|                           | Ankle                | EDB     | NR           | NR             | NR            | NR                   | Ankle - EDB        | 80            |               |                | 26.1       |
|                           | L Peroneal - EDB     |         |              |                |               |                      |                    |               |               |                |            |
|                           | Ankle                | EDB     | NR           | NR             | NR            | NR                   | Ankle - EDB        | 80            |               |                | 25.7       |
|                           | R Tibial - AH        |         |              |                |               |                      |                    |               |               |                |            |
|                           | Ankle                | AH      | NR           | NR             | NR            | NR                   | Ankle - AH         | 80            |               |                | 26.1       |
|                           | L Tibial - AH        |         |              |                |               |                      |                    |               |               |                |            |
|                           | Ankle                | AH      | NR           | NR             | NR            | NR                   | Ankle - AH         | 80            |               |                | 25.9       |
|                           | R Peroneal - Tib Ant |         |              |                |               |                      |                    |               |               |                |            |
|                           | Fib Head             | Tib Ant | NR           | NR             | NR            | NR                   | Fib Head - Tib Ant |               |               |                | 26.1       |
|                           | L Peroneal - Tib Ant |         |              |                |               |                      |                    |               |               |                |            |
| Fib Head                  | Tib Ant              | 6.35    | 0.5          | 16.20          | 3.7           | Fib Head - Tib Ant   |                    |               |               | 25.7           |            |
| Pop fossa                 | Tib Ant              | 11.30   | 0.6          | 14.53          | 4.0           | Pop fossa - Fib Head | 110                | 4.95          | 22            | 25.7           |            |

| Needle EMG    |                                |             |           |       |        |           |        |           |        |                     |
|---------------|--------------------------------|-------------|-----------|-------|--------|-----------|--------|-----------|--------|---------------------|
|               | Muscle                         | Nerve       | IA        | Fibs  | Amp    | Amp Value | Poly   | Recruit   | Rate   | Comments            |
| Baseline EDX  | R. Tibialis anterior           | Dp Br Peron | Increased | 3+/3+ | Normal |           |        | None      |        |                     |
|               | R. Gastrocnemius               | Tibial      | Increased | 1+/1+ | Normal | 1500      | Many   | Reduced   | Normal | Motor unit drop out |
|               | R. Vastus lateralis            | Femoral     | Increased | 1+/2+ | Normal |           | Normal | Mod Decr  | Normal |                     |
| Follow Up EDX | L. Tibialis anterior           |             | Normal    | 4+    |        |           |        |           |        | Single MUP          |
|               | L. Gastrocnemius (Medial head) |             | Normal    | 3+    | Normal |           | None   | Mark Decr | Normal |                     |
|               | L. Vastus lateralis            |             | Normal    | 2+    | Normal |           | None   | Mod Decr  | Normal |                     |

Baseline EDX Waveforms



Follow Up EDX Waveforms



Follow-Up

At 2-month follow up in clinic, she progressed to a limited community ambulator still requiring her walker and orthoses due to continued foot drop. A complete follow-up EDX test was completed and abbreviated findings are seen to the left in grey.

Discussion

The limited EDX study demonstrated a polyneuropathy due to both demyelinating and axonal processes as seen with the prolonged latencies, slowed conduction velocities, reduced CMAP amplitude and abnormal spontaneous potentials (fibrillation and positive sharp waves). The pattern appears to be primarily a length - dependent polyneuropathy with increased involvement of the more distal segments (distal>proximal left peroneal nerve slowing). In previous studies, N<sub>2</sub>O-induced neuropathy was regarded as an axonal type neuropathy with length –dependence features which is comparable to this case.

The patient had continued bilateral foot drop at her follow-up with repeat EDX testing demonstrating persistent abnormal spontaneous potentials despite improved conduction velocities. There were no findings of continued demyelination in the follow-up EDX study; however, the results suggest that the patient’s chronic, high-dose N<sub>2</sub>O toxicity caused irreversible axonal damage and a poor long-term prognosis. This is one of few cases that compare serial EDX findings in N<sub>2</sub>O-induced neuropathy.

Conclusion

Serial electrodiagnostic testing may be a useful prognostic tool for evaluating patients with N<sub>2</sub>O-induced peripheral polyneuropathy.

References

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