From Punching Bag to Foot Drop: A Case Study

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Case Presentation

12-year-old boy who presents to neuromuscular clinic as a follow-up after acute-onset lower extremity weakness and sensory loss after exercising with a punching bag one year ago.

Timeline

- **30 minutes: Onset of symptoms**
  - Back pain with radiation to right lower extremity
  - Weakness of right lower extremity with immobility of the toes on the right foot
  - Numbness on dorsal aspect of right foot involving all toes
- **Two days: Presents to Pediatrician**
  - Regained some ability to walk
  - Unable to walk up steps or run
  - Referred to PT and neurology
- **Two months: General Neurology**
  - 3/5 weakness right anterior tibialis
  - 4/5 weakness left gastrocnemius
  - 1+ patellar and ankle reflexes on right
  - Decreased cold sensation in stocking-glove distribution, more prominent on right
  - Screening labs ordered; EMG scheduled
- **Three months: Initial EMG (Figure 1.)**
- **Five Months: Scheduled Admission**
  - MRI and LP Obtained **(Figure 2. and Figure 3.)**
  - IVIG administered, but family declined monthly IVIG
- **Six Months: Neuromuscular Follow-up**
  - Improvement in heel walk, unable to toe walk, some difficulty with tandem gait
  - Unclear if improvement is due to initial IVIG versus continued PT, hold off on IVIG
- **Nine Months: Neuromuscular Follow-up**
  - Can now fully heel walk, run short distances, improved tandem
  - Slapping gait L >R, still limited in toe walking
- **One Year: Neuromuscular Follow-up**
  - Family suspects progressive lower extremity weakness for past two months

Exam

- **General**
  - Bilateral lower limb atrophy, more prominent on the left
- **Motor:**
  - Bilateral weakness of knee flexion against resistance
  - Right-sided weakness of plantarflexion against resistance
  - Difficulty standing from a squatting position
- **Sensory**:
  - No obvious sensory deficits
- **Reflexes:**
  - Reflexes 2+ throughout with down going toes bilaterally.
- **Gait:**
  - Unstressed gait, able to walk on heels and toes, no difficulty with tandem

Medical and Family History:

- Active baseball player before the incident
- No significant findings in family history, though grandparents hold custodianship

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Results

Electrodiagnostic Testing: Nerve Conduction Studies and Electromyography

Sensory Nerve/Sites	Rec. Site	Onset Latency ms		Peak Latency ms		NP Amp. µV		Segments	Distance cm		Velocity Peak m/s		Velocity m/s	
		Before	After	Before	After	Before	After		Before	After	Before	After	Before	After
R. Sural - Ankle (Calf)														
Calf	Ankle	2.34	2.81	2.92	3.39	21.3	10.9	Calf-Ankle	12	13.5	41.1	39.9	51.2	48
L. Sural - Ankle (Calf)														
Calf	Ankle	2.29	2.45	2.86	3.07	**16.2**	14.8	Calf-Ankle	12	12	41.9	39.1	52.4	49
R. Superficial Peroneal – Ankle														
Lat. Leg	Ankle	2.24	2.45	2.97	3.13	**10.5**	**10.9**	Lat. Leg-Ankle	14	14	47.2	44.8	62.5	57.2
L. Superficial Peroneal – Ankle														
Lat. Leg	Ankle	2.19	2.34	2.97	3.07	14.5	20.7	Lat. Leg-Ankle	14	12	47.2	39.1	64	51.2

Motor Nerve/ Sites	Muscle	Latency ms		Duration ms		Amplitude mV		F-Wave ms		Segments	Distance cm		Lat. Diff ms		Velocity m/s		Temperature C	
		Before	After	Before	After	Before	After	Before	After		Before	After	Before	After	Before	After	Before	After
L. Peroneal – EDB								**NR**	42									
Ankle	EDB	3.44	3.85	5.1	5.42	5	7.1			Ankle - EDB	8	8	-	-	-	-	31.2	29.9
Fibular Head	EDB	8.8	9.11	5.73	5.68	4.3	6.8			Fib. Head - Ankle	28.5	28	5.36	5.26	53	53	32.2	29.9
Popliteal Fossa	EDB	10.31	11	5.83	5.57	4	6.9			Pop. Fossa - Fib. Head	8	10	1.51	1.88	53	53	32.4	29.9
R. Peroneal – EDB								43	44									
Ankle	EDB	3.39	3.65	5	5.31	**4.8**	6.7			Ankle - EDB	8	8	-	-	-	-	31.2	30.1
Fibular Head	EDB	8.96	9.17	5.47	5.36	**4.5**	6.4			Fib. Head - Ankle	28.5	27.5	5.36	5.52	53	50	32.2	29.4
Popliteal Fossa	EDB	10.47	10.8	5.52	5.47	**4.5**	6.3			Pop. Fossa - Fib. Head	8	10	1.51	1.67	53	60	32.4	29.2
L. Tibial – AH								**48**	45									
Ankle	AH	3.33	3.02	5.57	5.94	**4.6**	**6.5**			Ankle - AH	8	8	-	-	-	-	31.3	32.6
Popliteal Fossa	AH	10.68	11.4	5.99	6.3	**3.8**	**5.2**			Pop. Fossa - Ankle	36	37	6.72	8.33	49	**44**	31	31
R. Tibial – AH								40	45									
Ankle	AH	3.07	3.39	4.84	6.72	10.5	10.7			Ankle - AH	8	8	-	-	-	-	32.6	28.9
Popliteal Fossa	AH	9.79	10.7	5.16	7.14	9.4	9.3			Pop. Fossa - Ankle	33	38	6.72	7.34	49	52	32.2	28.8

EMG Summary Table		Spontaneous										Motor Unit Action Potentials						Recruitment Pattern	
Muscle	Nerve	Roots		Insertional Activity		Fibrillation		Positive Sharp Wave		Fasciculation		High Frequency		Amplitude		Duration		Polyphasic Potentials			
				Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
L. Lumbar paraspinals		NA		N	-	N	-	N	-	N	-	N	-	Normal	-	Normal	-	Normal	-	Normal	-
L. Gluteus medius	Superior gluteal	L4-S1		N	-	N	-	N	-	N	-	N	-	Normal	-	Normal	-	Normal	-	Normal	-
L. Rectus femoris	Femoral	L2-L4		N	-	N	-	N	-	N	-	N	-	Normal	-	Normal	-	Normal	-	Normal	-
L. Vastus lateralis	Femoral	L2-L4		N	-	N	-	N	-	N	-	N	-	Normal	-	Normal	-	Normal	-	Normal	-
L. Biceps femoris (short head)	Sciatic (peroneal division)	L5-S2		N	-	N	-	**3+**	-	None	-	None	-	**2+**	-	**1+**	-	**1+**	-	**Reduced**	-
L. Tibialis Anterior	Deep peroneal (fibular)	L4-L5		N	N	N	N	N	N	N	N	N	N	**1+**	N	**1+**	**1+**	**1+**	N	**Reduced**	N
L. Gastrocnemius (medial head)	Tibial	S1-S2		N	-	N	-	None	-	N	-	N	-	N	-	**1+**	-	N		**Reduced**	-
R. Gluteus medius	Superior gluteal	L4-S1		N	-	N	-	None	-	N	-	N	-	N	-	N	-	N		Normal	
R. Tibialis anterior	Deep peroneal (fibular)	L4-L5		**2+**	N	**2+**	N	**2+**	N	N	N	N	N	**1+**	**1+**	**1+**	**1+**	**1+**	N	**Reduced**	**Reduced**
R. Gastrocnemius (medial head)	Tibial	S1-S2		N	N	N	N	N	N	N	N	N	N	N	N	N	**1+**	**1+**	N	Normal	Normal
R. Biceps femoris	Sciatic (peroneal division)	L5-S2		-	N	-	**1+**	-	**1+**	-	N	-	N	-	**1+**	-	**1+**	-	N	-	**Reduced**

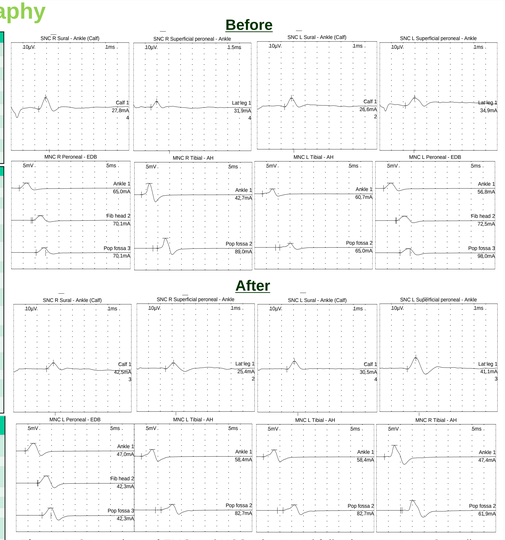

Figure 1. Comparison of EMG and NCS prior to and following treatment. Overall, there is improvement in motor and sensory responses of the lower limbs. Presence of diminished SNAP amplitudes suggests damage to multiple peripheral nerves in the bilateral lower extremities. Diminished CMAP amplitudes are suggestive of axonal damage to right peroneal and left tibial nerves. Slowed conduction velocities indicate a demyelinating pattern of injury. Notably, initially absent F-wave at left peroneal nerve indicating conduction block and increased latency at left tibial.

Imaging: MRI of Lumbar Spine

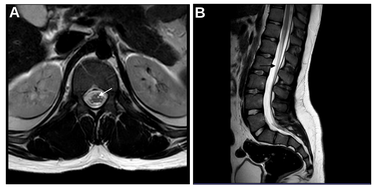

Figure 2. A. Areas of T2 hyperintensity present bilaterally at the anterior conus (noted white arrow) B. Sagittal T2 view with demonstrating longitudinal hyperintensity located at anterior conus (noted by black arrow). Of note, T1 pre- and post-contrasted studies were performed and notably did not show enhancement of nerve roots.

Laboratory Testing

Laboratory Test	Result	Interpretation
	Two Months: Screening Laboratory Testing	
Creatine Kinase	359 units/Liter	Mild Nonspecific Elevation
ESR and CRP	6 and 0.1 respectively	Both Normal
HgbA1c	5.3	Normal
B12 and Folate	352 and >24 respectively	Both Normal
Serum ACE, ANCA, and ANA	63, negative, negative	All Normal
SPEP	No abnormal protein bands detected	Normal
TSH/FT4	1.06/0.99	Both Normal
GQM1b,GM1,NS6S, Neurofascin 155 and 140	Negative	Normal
	Five Months: Scheduled Inpatient Admission	
CSF (WBC/Prot/Gluc)	0/32/59	Normal
Genetic Panel	VUS SH3TC2 c.1823G>A (p.Ser608Asn)	Associated with autosomal recessive Charcot-Marie-Tooth disease type 4C
	One Year: Neuromuscular Followup	
Antibody Panel for Sensorimotor Polyneuropathies	Antibodies against fibroblast growth factor 3	

Figure 3.
Table shows in timeline format the progressive work-up performed for this patient. Initial screening labs were aimed at screening for a myopathic or neuropathic etiology, but results were unrevealing other than a mild elevation in Creatine Kinase levels. Cerebrospinal fluid studies were also unrevealing and notably did not show signs of albuminocytologic disassociation. It remains unclear whether the VUS discovered on genetic panel contributed to this patient's phenotype.
Unfortunately, given parental testing was not possible. Diagnosis of CISP+ made with support from the antibodies found against fibroblast growth-factor 3.

Follow-up

- **Thirteen Months: Phone Call**
  - Family agreed to empiric oral steroids
- **Sixteen Months: Neuromuscular Follow-up**
  - Antibody titers returned positive for FGFR3
  - Diagnosis made of anti-FGFR3 positive chronic immune sensory polyradiculoneuropathy+ (CISP+)
  - Family declined IVIG and opted to continue oral steroids
- **Nineteen Months: Second EMG Performed (Figure 1.)**
  - Interval strength increase (Figure 4.)
  - Practicing to rejoin soccer team next year

Manual Motor Testing		
Motion	Before Steroids (R,L)	After Steroids (R,L)
Hip Adduction	5,5	5,5
Hip Abduction	5,5	5,5
Hip Flexion	5,5	5,5
Hip Extension	5,5	5,5
Knee Flexion	4,4	**5,5**
Knee Extension	5,5	5,5
Foot Inversion	5,4+	**5,5-**
Foot Eversion	4+,4+	**5,5**,
Ankle Dorsiflexion	5,5	5,5
Ankle Plantarflexion	4,5	**5**,5
Toe Extension	5,5	5,5-
Toe Flexion	5,5	5,5-

Figure 4. Comparison of manual motor testing prior and following oral steroid course showing overall improvement.

Discussion

Chronic Immune Sensory Polyradiculoneuropathy +

- Classic CISP is a CIDP variant
  - Characterized by sensory loss due to focal sensory root demyelination
  - EMG/NCS: Normal sensory nerve conduction studies
    - Because of damage to the dorsal root ganglion[1]
  - MRI: May see enhancement of the dorsal roots
  - CSF: May see albuminocytologic dissociation
  - Biopsy: Performed on lumbar rootlets. Shows loss of myelinated large fibers, onion-bulb formation, and presence of endoneurial macrophages[2]
- CISP+ also involves motor and some distal sensory nerves[3]
- Anti-FGFR3 antibody positive polyneuropathies
  - Have tendency to involve the dorsal root ganglion
  - Show variable expression patterns, influenced by the involved epitope[4]
- Challenges in pediatrics
  - The workup for acquired neuropathies is complicated by a differential that is broadened by the potential for hereditary neuropathies
  - Technically, successful performance of EMG/NCS relies on patient cooperation which is challenging with children and in some cases may require sedation
  - Neither CISP nor CISP+ is well reported in children
    - Therefore, it remains unclear whether the clinical presentation is significantly different from that seen in the adult population
- Management
  - Initial management is usually Intravenous Immunoglobulin or oral steroids
    - If refractory to the above may consider plasma exchange
  - Physical therapy is paramount for adequate recovery
  - It is beneficial to repeat EMG/NCS to assess treatment response

References

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