Muscle Imbalance and Altered Gait

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Conflicts of Interest

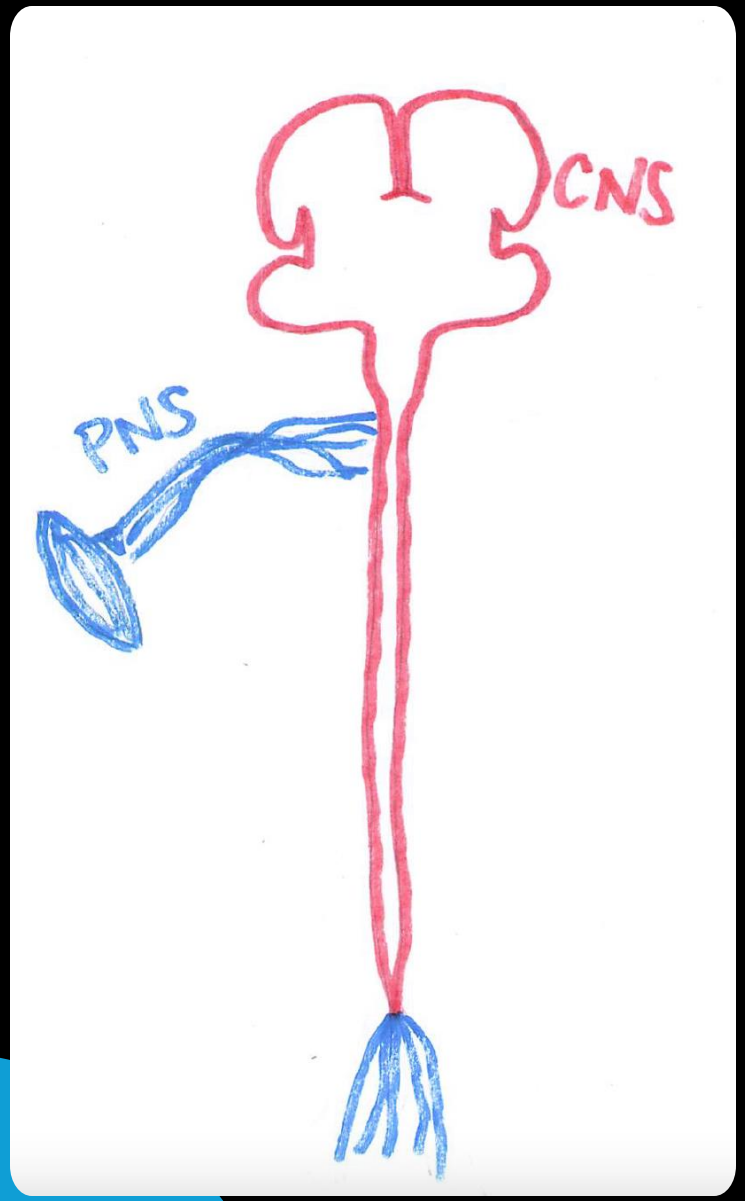
- None identified

Objectives

1) Analyze fundamental components of the gait cycle and identify abnormalities associated with muscle imbalance.

2) Differentiate between various neurologic gait patterns

3) Formulate a differential diagnosis for various altered gait patterns and identify appropriate workup.



- CNS
  - Best test = MRI
- PNS
  - Best test = electrodiagnostic testing (NCS + EMG)

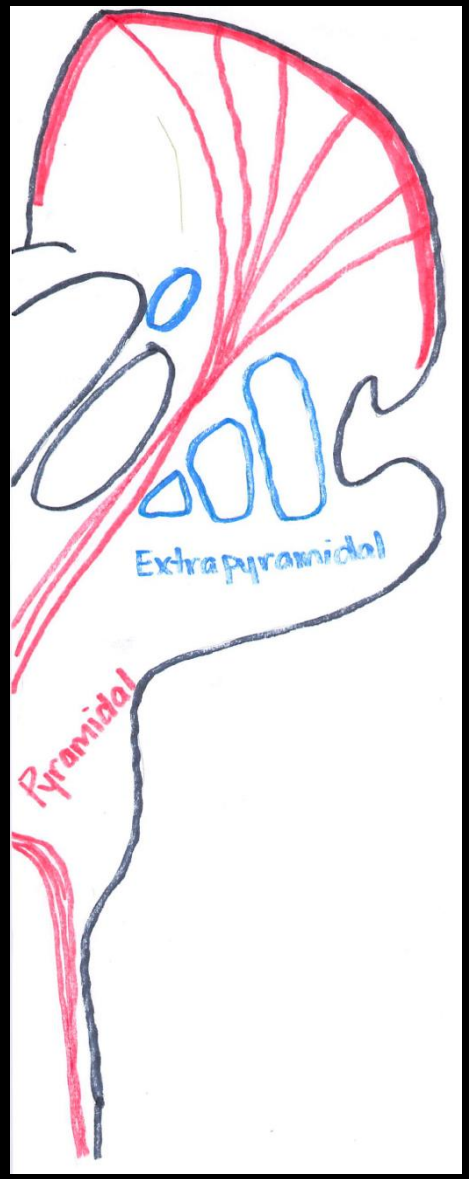
UMN vs LMN

UMN

- ↑ tone
- ↑ reflexes
- ↑ toes

LMN

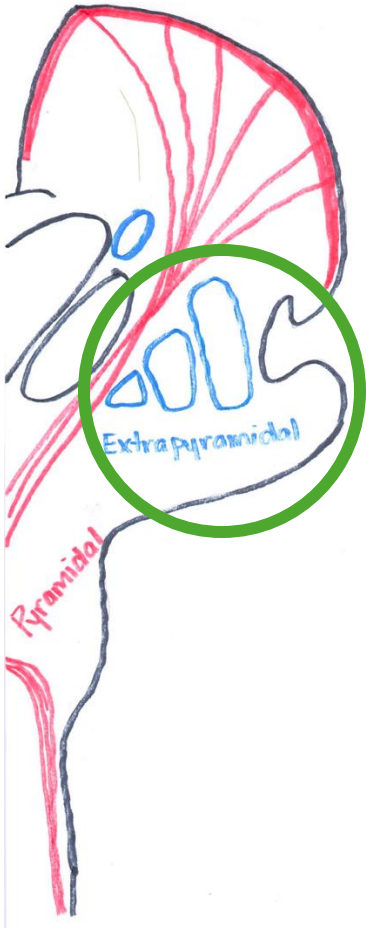
- ↓ tone
- ↓ reflexes
- ↓ toes
- ↓ muscle bulk
- fasciculations


Extrapyramidal
Pyramidal

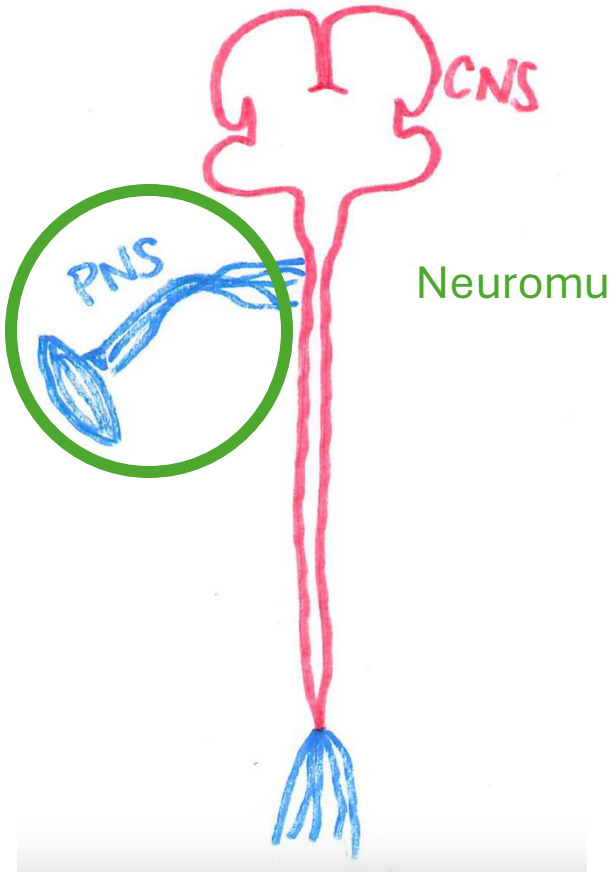
Pyramidal Weakness

Weak *extensors* in the upper extremity

Weak *flexors* in the lower extremity



Movement Disorders



Neuromuscular

Localization Pearls

Pain, burning, and tingling sensations typically do not originate from lesions in the brain

Exception: thalamic pain syndrome

Symptoms affecting one hemibody (face, arm, and leg) suggest a lesion in the brain.

London, Z. 2020. A Structured Approach to the Diagnosis of Peripheral Nervous System Disorders. *Continuum* 26(5)

Localization Pearls

Ascending sensory loss may indicate either peripheral neuropathy or spinal cord pathology.

- By the time neuropathy reaches the knees, the distal parts of the upper limbs are generally affected as well.
- Numbness extending above the groin without upper extremity involvement suggests spinal cord pathology.

The presence of sensory symptoms excludes localization to the anterior horn, neuromuscular junction (NMJ), or muscle, as these areas do not produce sensory deficits.

London, Z. 2020. A Structured Approach to the Diagnosis of Peripheral Nervous System Disorders. *Continuum* 26(5)

Weakness Mimics

- Generalized fatigue
- Arthralgia
- Myalgia
- Deconditioning
- Depression

Weakness Mimics

Ask about function

Proximal

- Hair
- Chair
- Stair

Distal

- Dexterity
- Tripping

Normal Gait Cycle

- Phases of the gait cycle:
  - Stance (60%)
  - Swing (40%)
- Key components: heel strike, foot flat, midstance, push-off, toe-off, midswing, terminal swing
- Joints and muscles involved: hip, knee, ankle, foot

Definitions

- Velocity: walked distance/time (m/s)
- Cadence: number of steps in a given time (steps/min)
- Step height: max distance between forefoot and ground during swing
- Symmetry: ratio between step lengths of 2 legs
- Coordination: timing of leg activation with respect to other leg

Definitions

- Step length: distance covered during swing phase
- Stride length: summation of distances of 2 steps (left + right)

Fasano, Alfonso; Bloem, Bastiaan R.Gait Disorders. 2013. *CONTINUUM*: 19(5):1344-1382, doi: 10.1212/01.CON.0000436159.33447.69

Definitions

- Step width: distance between 2 feet for a given step

Fasano, Alfonso; Bloem, Bastiaan R.Gait Disorders. 2013. *CONTINUUM*: 19(5):1344-1382, doi: 10.1212/01.CON.0000436159.33447.69

Neurological Control of Gait

- Cortex, cerebellum, basal ganglia, brainstem, and spinal cord role in gait control
- Higher-order control: motor cortex planning, cerebellum for coordination
- Spinal circuits: central pattern generators (CPGs)

Abnormal Gait Patterns – Broad Categories

- Spastic
- Ataxic
- Parkinsonian
- Hemiplegic
- Neuropathic
- Waddling
- Antalgic

Spastic Gait

- Characterized by stiff, scissoring leg movement, leg extension, plantar flexion, circumduction
- Caused by upper motor neuron lesions (e.g., stroke, cerebral palsy, multiple sclerosis)
- Clinical features: hypertonia, increased reflexes

Ataxic Gait

- Wide-based, unsteady, staggering gait
- Often seen in cerebellar dysfunction (e.g., cerebellar ataxia, intoxication)
- Can be seen in sensory disorders (particularly large fibre) with reduced proprioception
- Clinical features: poor coordination, difficulty with tandem walking, difficulty with turn

Parkinsonian Gait

- Slow, shuffling steps, reduced arm swing, forward flexed posture
- Cause: basal ganglia dysfunction. Typical in Parkinson’s disease, NPH, vascular disease (lower body parkinsonism)
- Clinical features: bradykinesia, rigidity, postural instability

Steppage

- High stepping due to foot drop
- Weakness of dorsiflexion
- Commonly L5 radiculopathy, peroneal neuropathy, sciatic neuropathy

Localization: Foot Drop

- L FIVE
  - Inversion and eversion
- Tibial nerve
  - Inversion
- Peroneal Nerve
  - Eversion

Distal Symmetric Polyneuropathy

Practice Parameter: Evaluation of distal symmetric polyneuropathy: Role of laboratory and genetic testing (an evidence-based review)
Report of the American Academy of Neurology, American Association of Neuromuscular and Electrodiagnostic Medicine, and American Academy of Physical Medicine and Rehabilitation
J. D. England, MD, G. S. Gronseth, MD, FAAN, G. Franklin, MD, G. T. Carter, MD, L. J. Kinsella, MD, J. A. Cohen, MD, A. K. Asbury, MD, et al.
January 13, 2009 issue
72 (2) 185-192
https://doi.org/10.1212/01.wnl.0000336370.51010.a1

Recommendations.

Screening laboratory tests may be considered for all patients with DSP (Level C). Although routine screening with a panel of basic tests is often performed (table e-1), those tests with the highest yield of abnormality are blood glucose, serum B12 with metabolites (methylmalonic acid with or without homocysteine), and serum protein immunofixation electrophoresis (Level C). When routine blood glucose testing is not clearly abnormal, other tests for prediabetes (impaired glucose tolerance) such as a GTT may be considered in patients with distal symmetric sensory polyneuropathy, especially if it is accompanied by pain (Level C).

Trendelenburg/Waddling Gait

- Seen in patients with proximal muscle weakness (e.g., myopathies, muscular dystrophy, myasthenia gravis)
- Characterized by a bilateral hip drop and body swaying side to side

Myopathies

Different patterns of weakness but *generally proximal*

Myopathy Workup

- Medication review
- CK
- AST, ALT, LDH
  - GGT can differentiate from liver
- Electrolytes
- TSH
- ESR and ANA if suspected inflammatory

Narrowing the Differential

- Does it localize to the CNS or to the PNS?
- Can it localize to a single named peripheral nervous system structure?
- If it is focal or generalized:
  - Does it involve sensory loss, weakness, or both?
  - Is it primarily proximal, distal, or both?
  - Is it symmetric or asymmetric?

London, Z. 2020. A Structured Approach to the Diagnosis of Peripheral Nervous System Disorders. *Continuum* 26(5)

Take Home Points

If CNS

- MRI

If PNS

- Lab work +/- electrodiagnostics

Take Home Points

Neuropathy

- Often length dependent, progressive
- Reduced reflexes
- UE involvement once symptoms are above knee

Myelopathy

- May be length dependent, progressive
- Brisk reflexes
- Symptoms extend above LE without UE involvement
- Check for sensory level
- MRI spine

Take Home Points

Neuropathy

- More likely distal
- A1C, B12, SPEP
- Electrodiagnostics if unusual features (asymmetric, rapidly progressive, family history)

Myopathy

- More likely proximal
- CK, AST, ALT, LDH, TSH
- Electrodiagnostics

References

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