Upper Motor Neuron
Lower Motor Neuron

David Brewer DVM, DACVIM (Neurology)
Objectives

• Fundamental differences between the UMN and LMN systems
• Typical symptoms seen with dysfunction
• Role in neurolocalization

• Cases examples
What we say to dogs:
Okay, Ginger! I've had it! You stay out of the garbage! Understand, Ginger? Stay out of the garbage, or else!

What they hear:
blah blah GINGER blah, blah, blah, blah, blah, blah, blah, blah GINGER blah, blah, blah, blah, blah, blah, blah...
UMN? LMN? Who Cares?

- Localization
Definitions

- UMN- The neurons of the brain that control motor activity of the body
Definitions

• UMN- Cell bodies are located in the cerebrum and brainstem
• Entire UMN is confined to CNS
Definitions

- LMN - the neurons that directly innervate the muscles.
Definitions

- **LMN**- Cell bodies are located in the ventral gray horn of the spinal cord
Functions

- **UMN**
  - ‘Tells’ the LMN what to do
  - Stimulate or inhibit the LMN
  - Initiation of voluntary movement
  - Maintenance of muscle tone and support against gravity
  - Regulation of posture
Functions

- LMN-
  - Receives inputs from the UMN
  - Connects the CNS with the muscles
  - Spinal reflexes
Dysfunction of the UMN

- Paretic (weakness) to paralysis
- Gait: (if still walking)
  - Long strided
  - Crossing
  - Scuffing
- Loss of inhibition:
  - Spasticity
  - Hyperreflexia / hypertonia / abnormal reflexes
- Abnormal postures (brain lesion)
  - Ex. opisthotonus
Dysfunction of the UMN

• Gait Generation
  ▪ Dogs/cats- brainstem
  ▪ People- cerebrum
Romy
Romy
Loss of Inhibition

1. Gravity (pleximeter) stimulates muscle spindle

2. Firing along Ia afferent

3. Stimulation of alpha motor neuron and muscle contraction

** Must be controlled by UMN system
Crossed Extensor Reflex
Dysfunction of the LMN

- Paretic (weakness) to paralysis
- Gait: (if still walking)
  - Short-strided
  - Choppy
  - Lame
- Hypotonia
- Hyporeflexive
- Rapid muscle atrophy
Postural Reactions

• Both UMN and LMN lesions can cause abnormal postural reactions
• More so with UMN
• Depends on severity
Goal: Neurolocalization

- How do we use UMN and LMN symptoms to help localize a lesion?
Goal: Neurolocalization

• The location of the lesion along the neuroaxis will determine which limbs are affected
  ▪ **UMN** symptoms will be present in limbs downstream from a CNS lesion
  ▪ **LMN** symptoms will only be present if the motor nerve or the intumescence is affected
Goal: Neurolocalization

- Symptoms can be isolated to one limb or generalized to all limbs.
- Not every symptom needs to be present to localize a region.
<table>
<thead>
<tr>
<th></th>
<th>Brain</th>
<th>C1-C5</th>
<th>C6-T2</th>
<th>T3-L3</th>
<th>L4-S3</th>
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UMN or LMN Bladder?
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Bladder

• UMN Bladder
  ▪ Seen with lesions cranial to L4
  ▪ Loss of inhibition causes excess tone on the urethral sphincters
  ▪ Large difficult to express
  ▪ Overflow incontinence
**UMN Bladder Treatment**

- **Relax Internal Urethral Sphincter**
  - Alpha-adrenergic antagonist
  - Ex. Phenoxybenzamine or Prazosin

- **Relax External Urethral Sphincter**
  - Skeletal muscle relaxant
  - Ex. Diazepam
Bladder

- LMN Bladder
  - Seen with lesions caudal to L4
  - Hypotonia of the urethral sphincters
  - Fills partially
  - Continuous dribbling
  - Easy to express
LMN Bladder Treatment

- Promote Bladder Contraction
  - Stimulate muscarinic receptors
    - Ex. Bethanechol
Technically Speaking

- LMN is referencing just the nerve

- What about the muscle or the junction between the nerve and muscle?
Neuromuscular System

- LMN (Neuropathy)
- Muscle (Myopathy)
- NMJ (Junctionopathy)
# Neuromuscular System

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<th>Neuropathy</th>
<th>NMJ</th>
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<tr>
<td>Muscle mass/tone</td>
<td>Normal to ↓</td>
<td>↓</td>
<td>Normal</td>
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<tr>
<td>Gait</td>
<td>Paresis</td>
<td>Paresis</td>
<td>Paresis may be episodic</td>
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<tr>
<td>Postural Reactions</td>
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<td>Normal</td>
</tr>
<tr>
<td>Reflexes</td>
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Case Example 1

- Middle-age German Shepherd
- CC: Wobbly in the pelvic limbs
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Differentials

• C6-T2 myelopathy
  ▪ **Degenerative** - IVDD
  ▪ **Anomalous** – Wobbler’s syndrome
  ▪ **Metabolic** - ??
  ▪ **Neoplastic**- Extradural or intramedullary
  ▪ **Inflammatory**- Immune-mediated or infectious
  ▪ **Traumatic / Toxic**- Contusion
  ▪ **Vascular**- FCE
Diagnostics
Diagnosis

• C6-T2 myelopathy
  ▪ Degenerative - IVDD
  ▪ **Anomalous – Wobbler’s syndrome**
  ▪ Metabolic - ??
  ▪ Neoplastic- Extradural or intramedullary
  ▪ Inflammatory- Immune-mediated or infectious
  ▪ Traumatic / Toxic- Contusion
  ▪ Vascular- FCE
Treatment and Outcome

• Treatment
  ▪ Owner elected conservative management

• Outcome
  ▪ Fair to good response to prednisone and life long gabapentin
Case Example 2

- Young Bichon
- CC: Down in pelvic limbs
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Differentials

- T3-L3 myelopathy
  - Degenerative - IVDD
  - Anomalous – Malformation, cyst
  - Metabolic - ??
  - Neoplastic- Extradural or intramedullary
  - Inflammatory- Immune-mediated or infectious
  - Traumatic- Contusion
  - Vascular- FCE
Diagnostics
Diagnosis

- T3-L3 myelopathy
  - Degenerative - IVDD
    - Anomalous – Malformation, cyst
    - Metabolic - ??
    - Neoplastic- Extradural or intramedullary
    - Inflammatory- Immune-mediated or infectious
    - Traumatic / Toxic- Contusion
    - Vascular- FCE
Treatment and Outcome

• Treatment
  ▪ Hemilaminectomy

• Outcome
  ▪ Normal at 6 weeks post surgery
Case Example 3

- Young adult Giant Schnauzer
- CC: Down in all 4
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Differentials

• Diffuse LMN Disease
  ▪ **Degenerative** – Hereditary?, Storage diseases
  ▪ **Anomalous** – ?
  ▪ **Metabolic** – Endocrine (DM, cortisol, thyroid)
  ▪ **Neoplastic**- Lymphoma, paraneoplastic
  ▪ **Inflammatory**- Polyradiculoneuritis, infectious – protozoal, (botulism)
  ▪ **Traumatic / Toxic**- (Tick paralysis)
  ▪ **Vascular**- ?
Diagnostics

- CBC – Normal
- Chem – Normal
- Urinalysis – Normal
- 3 view chest radiographs – Normal
- Abdominal Ultrasound – Normal
- Baseline cortisol and T4 – Normal
Additional Diagnostics

• Electrodiagnostics
  ▪ Electromyography
  ▪ Motor Nerve Conduction Velocity
  ▪ F-Waves
• +/- Muscle nerve biopsy
Updated Differentials

• Diffuse LMN Disease
  ▪ **Degenerative** – Hereditary?, Storage diseases
  ▪ Anomalous – ?
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  ▪ **Neoplastic**- Lymphoma, paraneoplastic
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  ▪ **Traumatic / Toxic**- (Tick paralysis)
  ▪ Vascular- ?
Treatment and Outcome

- Treatment
  - Frontline application

- Outcome
  - ~2 weeks later – 90%
  - ~4 weeks later – 100%
Presumptive Diagnosis

- **Diffuse LMN Disease**
  - Degenerative – Hereditary?, Storage diseases
  - Anomalous – ?
  - Metabolic – Endocrine (DM, cortisol, thyroid)
  - Neoplastic- Lymphoma, paraneoplastic
  - **Inflammatory- Polyradiculoneuritis**, infectious – protozoal, *botulism*
  - Traumatic / Toxic- *Tick paralysis*
  - Vascular- ?
Case Example 4

- 2 yr old Newfoundland
- CC: Unable to walk
Case Example 4
Take Home Points

- UMN disease should have distinctly different signs from LMN disease
- Cervical spinal cord disease and diffuse LMN disease can sometimes be confused without thorough examination
- Diseases that affect the neuromuscular system can look very similar
- Gait evaluation is probably the most important aspect of the exam
- Acute localization is key!
QUESTIONS?