The Neurologic Exam
And
Lesion Localization

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July 16, 2017
What is the goal of the neuro exam?

- Neuroanatomically localize the lesion
- Remember that it is the location of the disease within the nervous system (not the disease) that determines the clinical signs
Brain

- Cerebrum (Hemispheres)
- Diencephalon (Thalamus)
- Mesencephalon (Midbrain)
  - CN – III and IV
- Metencephalon (Pons)
  - CN – V
- Myelencephalon (Medulla)
  - CN – VI-XII
- Cerebellum
Spinal Cord Anatomy

• Spinal Segments (Not Vertebrae)
  ▪ C1-C5
  ▪ C6-T2
  ▪ T3-L3
  ▪ L4-S2 (3)
    • L4-L6 (Femoral N.)
    • L6-S2(3) (Sciatic N.)
Neurologic Examination

- History/Signalment
- Mental Status
- Gait and Posture
- Postural Reactions
- Cranial Nerves
- Spinal Reflexes
- Spinal Pain
- Nociception
- Syndrome/Localization
- Differential Diagnoses
History/Signalment

- Establish time line
- Review pertinent medical history
- Define chief complaint
Observation

• Look at the patient
  ▪ Level of Consciousness
    • Alert
    • Depressed/Obtunded – drowsy but arousable with mild stimulus
    • Stuporous – patient in a “sleep state,” but arousable with noxious stimulus
    • Comatose – patient unconscious
Gait Analysis

- Lameness
- Ataxia
  - Spinal/proprioceptive ataxia
  - Cerebellar ataxia
  - Vestibular ataxia
- Paresis--weakness
- Paralysis/plegia
Posture

- Position of head and body with respect to gravity
- Examples:
  - Wide-base stance
  - Decerebrate rigidity
  - Decerebellate rigidity
  - Opisthotonus
  - Schiff-Sherrington
Postural Reactions

- Proprioceptive positioning (knuckling)
  - Ortho disease vs. neuro disease
- Hopping
- Hemistanding and hemiwalking
- Wheelbarrow
- Extensor postural thrust
Postural Reactions

Hopping

Hemiwalking/Hemistanding
Postural Reactions

Wheelbarrow

Extensor Postural Thrust
Cranial Nerves

I. Olfactory *
II. Optic
III. Oculomotor
IV. Trochlear
V. Trigeminal
VI. Abducent
VII. Facial
VIII. Vestibulocochlear
IX. Glossopharyngeal
X. Vagus
XI. Accessory
XII. Hypoglossal
Cranial Nerve II: Optic

- Menace Response
- II to see, VII to blink
  - May be absent in puppies and kittens younger than 12 weeks
  - Ipsilateral cerebellar lesion
- Following (cotton ball)
- Obstacle Course
Cranial Nerves III, IV, and VI: Oculomotor, Trochlear, and Abducent

- Control eye movements
- Look for strabismus
- Observe eye movements as patient looks around
- Move head up and down AND left and right to induce normal nystagmus
Ocular Muscle Anatomy

- Dorsal oblique
- Medial rectus (CN III)
- Dorsal oblique (CN IV)
- Dorsal rectus (CN III)
- Dorsal rectus (CN III)
- Lateral rectus (CN VI)
- Lateral rectus (CN VI)
- Ventral rectus (CN III)
- Ventral rectus (CN III)
- Ventral oblique (CN III)
- Ventral oblique (CN III)
Cranial Nerve III: Oculomotor (PLR)

Pupillary Constriction
PARASYMPATHETIC PATHWAY

CONSENSUAL
50% pupillary constriction

DIRECT
100% pupillary constriction
Cranial Nerve V: Trigeminal

- **Motor**
  - Symmetry of masseter and temporalis

- **Sensory**
  - Ophthalmic—medial canthus
  - Maxillary—lateral canthus
  - Mandibular—lower lip
Cranial Nerve VII: Facial

- Observe for symmetry (eyelids, ears, lips)
- Palpebral reflex
- Muzzle/lip Movement
- Evaluate tearing with Schirmer tear test
Cranial Nerve VIII: Vestibulocochlear

- **Auditory**
  - BAER
  - Make an unexpected noise

- **Vestibular System**
  - Central vs. peripheral
  - Head tilt, abnormal nystagmus, ataxia, broad-based stance, falling, rolling
  - Elicit positional nystagmus or strabismus
Cranial Nerve VIII: Vestibulocochlear
Cranial Nerves IX and X: Glossopharyngeal and Vagus

- Considered together
- Ask client about dysphagia, regurgitation, voice change, etc.
- Test with gag reflex
Cranial Nerve XI: Spinal Accessory

- Deficits may result in atrophy of the trapezius muscle
Cranial Nerve XII: Hypoglossal

• Look for asymmetry, atrophy, movement of tongue
• Innervation to striated muscles of the tongue
Horner’s Syndrome

- Miosis
- Enophthalmos
- Ptosis
- Prolapsed 3rd eyelid
Horner’s Syndrome

- Midbrain
- Lateral Tectotegmental Spinal Tract
- Exits T1-T3
- Rami Communicans
- Vagosympathetic Trunk
- Cranial Cervical Ganglion
- Ophthalmic branch of CN V
Any Questions About Cranial Nerves?
# Spinal Reflexes

<table>
<thead>
<tr>
<th>Reflex</th>
<th>Nerve</th>
<th>Spinal Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps</td>
<td>Musculocutaneous</td>
<td>C6-T1</td>
</tr>
<tr>
<td>Triceps/Extensor Carpi Radialis</td>
<td>Radial</td>
<td>C7-T2</td>
</tr>
<tr>
<td>Flexor withdrawal (forelimb)</td>
<td>Ulnar, median, musculocutaneous</td>
<td>C6-T2</td>
</tr>
<tr>
<td>Cranial Tibial</td>
<td>Peroneal (sciatic)</td>
<td>L6-L7</td>
</tr>
<tr>
<td>Patellar</td>
<td>Femoral</td>
<td>L4-L6</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Sciatic</td>
<td>L7-S1</td>
</tr>
<tr>
<td>Flexor withdrawal (pelvic limb)</td>
<td>Sciatic</td>
<td>L6-S1</td>
</tr>
<tr>
<td>Perineal</td>
<td>Pudendal</td>
<td>S1-S3</td>
</tr>
<tr>
<td>Cutaneous Trunci</td>
<td>Lateral thoracic</td>
<td>C8-T1</td>
</tr>
</tbody>
</table>
Forelimb Reflexes

Biceps
Triceps
ECR
Withdrawal
Hind limb Reflexes

- Cranial Tibial
- Patellar
- Gastrocnemius
- Withdrawal
Cutaneous Trunci

- Afferent
  - Spinal
- Efferent
  - Lateral Thoracic
Other Spinal Reflexes

Perineal S1-S3

Babinski
Spinal Pain/Palpation

- Palpate entire spine
- Cervical range of motion
  - Dorsal, ventral, left and right lateral
- Rectal exam
- Can perform in lateral recumbency
  - Avoids loading joints
Nociception

PROPRIOCEPTION

PARESIS

PARALYSIS

LOSS OF SENSATION
Nociception

- Superficial pain (skin)
- Deep pain (bone)
Moving on to Lesion Localization
Remember, Localization is the Goal!

- Forebrain (including diencephalon)
- Brainstem (midbrain, pons, medulla)
- Cerebellum
- Cervical spinal cord
- CT spinal cord
- TL spinal cord
- LS spinal cord
- Neuromuscular

- Don’t forget about multifocal disease
Neuroanatomic Localization

- Neurologic signs are caudal to lesion
- To localize the lesion we interrogate the CNS
  - Cranial nerves
  - Cervical intumescence
    - Triceps reflex – Radial N.
    - Biceps reflex – Musculocutaneous N.
    - Withdrawal reflex
  - Lumbar intumescence
    - Patellar reflex – Femoral N.
    - Cranial tibial reflex – Common peroneal N.
    - Withdrawal reflex
  - Cutaneous trunci
    - Dorsal spinal and Lateral thoracic (C8-T1)
- Intercapital ligament
  - Low incidence of disc extrusions between T2-T11
Forebrain (Hemisphere, Thalamus) Localization

• Clinical Signs
  ▪ Contralateral postural deficits
  ▪ Contralateral decrease in nasal sensation
  ▪ Dullness, stupor, coma
  ▪ Loss of learned behaviors
  ▪ Cognitive
    • Thought, Thinking
  ▪ Pacing
  ▪ Staring off
  ▪ Seizures
  ▪ Circling
Obtunded Stray
Brainstem Localization

- Mesencephalon (Midbrain), Metencephalon (Pons), Myelencephalon (Medulla), Cerebellum
- Clinical signs
  - Ipsilateral Deficits
  - Altered level of Consciousness (ARAS)
  - CNN III-XII
  - Ataxia, dysmetria
  - Gait abnormalities
  - Vestibular
## Vestibular Localization

<table>
<thead>
<tr>
<th></th>
<th>Peripheral</th>
<th>Central</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head tilt</td>
<td>Yes (ipsilateral)</td>
<td>Yes (ipsilateral, may be contralateral with paradoxical disease)</td>
</tr>
<tr>
<td>Ataxia</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nystagmus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--Horizontal</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>--Rotary</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>--Vertical</td>
<td>No (?)</td>
<td>Yes</td>
</tr>
<tr>
<td>--Positional</td>
<td>Rarely</td>
<td>Yes</td>
</tr>
<tr>
<td>Postural Reaction Deficits</td>
<td>No</td>
<td>Yes (ipsilateral)</td>
</tr>
<tr>
<td>Circling</td>
<td>Yes (ipsilateral)</td>
<td>Yes (either direction)</td>
</tr>
<tr>
<td>Facial Paralysis</td>
<td>Yes (ipsilateral)</td>
<td>Not typically</td>
</tr>
<tr>
<td>Horner’s Syndrome</td>
<td>Yes (ipsilateral)</td>
<td>Not typically</td>
</tr>
</tbody>
</table>
Vestibular Disease

• Fast phase of nystagmus runs away from the lesion (usually)
• Bilateral—wide head excursions
• Paradoxical
  ▪ Side of CP deficits
  ▪ Head tilt opposite
Vestibular Disease
Cerebellar Localization

- Intention tremor
- Dysmetria (Hypermetria)
- Ipsilateral menace deficit
- No CP deficits
- Decerebellate posture if severe
C1-C5 Localization

- Cranial nerves
  - +/- Ipsilateral Horner’s
- Posture
  - Scoliosis
  - Torticollis
- Gait
  - Tetra/Hemi paresis
  - Tetra/Hemi plegia
- Postural reactions
  - Postural deficits (normal to decreased to absent x 4)
- Reflexes
  - Normal to hyper-reflexive x 4 limbs
  - Normal to increased muscle tone x 4 limbs
- Bladder
  - +/- Normal or large and firm
- Respiratory Failure
  - Phrenic N (C5-C7)
C1-C5 Localization
C6-T2 (Cervical Intumescence) Localization

- Cranial nerves
  - +/- Ipsilateral Horner’s
- Thoracic limb
  - Brachial plexus avulsion
  - Monoparesis/plegia
- Posture
  - Torticollis, nerve root signature
- Gait
  - Tera/Hemi paresis
  - Tetra/Hemi plegia
- Postural reactions
  - Postural deficits (normal to decreased to absent x 4)
- Reflexes
  - Normal to hyper-reflexive hind limbs
  - Decreased to absent reflexes forelimbs
  - Reduced to absent cutaneous trunci
- Bladder
  - +/- Normal or Large and firm
C6-T2 (Cervical Intumescence) Localization
T3-L3 Localization

- Thoracic limbs
  - Normal
- Gait (Pelvic limbs)
  - Spastic
  - Mono/Para paresis
  - Mono/Para plegia
- Postural reactions
  - Postural deficits (one or both limbs)
- Reflexes
  - Normal to hyper-reflexive
  - Reduced to absent cutaneous trunci
- Bladder
  - +/- Normal or Large and firm
  - Overflow incontinence
  - Increased urethral sphincter tone
T3-L3 Localization
Schiff-Sherrington

• Clinical signs
  ▪ Severe extensor rigidity of thoracic limbs with flaccid paralysis of pelvic limbs
    • Normal movement of thoracic limbs
    • Disinhibition of extensor motor neurons
    • Injury to Border Cells
      – Gray matter from spinal segments L1-L5
      – Synapse on thoracic limb extensor LMNs in the cervical intumescence
    • Possible areflexia in pelvic limbs

• Take away
  ▪ Schiff-Sherrington indicates a severe lesion
  ▪ It is NOT a prognostic indicator!
Myelomalacia
L4-S3 Localization

- Thoracic limbs
  - Normal
- Gait (Pelvic limbs)
  - Short strided
  - Mono/Para paresis
  - Mono/Para plegia
  - Plantigrade
- Postural reactions
  - Postural deficits (one or both limbs)
- Reflexes
  - Decreased to absent reflexes
- Tail
  - Normal, Paresis, Plegia
  - Loss of perineal reflex and sensation
- Bladder
  - Flaccid bladder
  - Loss of urethral sphincter tone
  - Incontinence
  - Internal urethral sphincter intact
Anatomy of the Bladder

- Hypogastric
  - Sympathetic L1-L4
    - $\alpha$-adrenergic to the urethra (increase tone)
    - $\beta$-adrenergic to the bladder (relax detrusor)

- Pelvic
  - Parasympathetic S1-S3
    - Contraction of detrusor
  - Afferent to sympathetic

- Pudendal
  - S1-S3
  - Somatic
Treatments for Micturition Disorders

- **Stimulate detrusor contraction**
  - Bethanechol
    - Via cholinergic
    - 1.25 -25 mg per day TID

- **Decrease urethral tone**
  - Diazepam
    - Skeletal muscle relaxant
    - 2-10 mg TID
  - Phenoxybenzamine
    - α-adrenergic antagonist
    - 0.25-0.5 mg/kg SID-BID
  - Prazosin
    - α 1-adrenergic antagonist
    - 1 mg/15kg SID-BID
Neuromuscular Localization

- Short choppy gait x 4 limbs, fatigues and then collapse
- Weak (crouched, trembling)
- Normal proprioception x 4 limbs
- Not ataxic
- Non-painful on spinal palpation
- Diminished to absent reflexes
- Denervation atrophy
- Perceives pain, unable to withdraw
- Fatiguing palpebral
- Regurgitation
Neuromuscular Localization
Differential Diagnoses

- D—degenerative
- A—anomalous (congenital)
- M—metabolic
- N—neoplastic, nutritional
- I—infectious, inflammatory, idiopathic
- T—trauma, toxin
- V—vascular
World’s Smallest Take Home Points

• Taking a thorough history is always important, but it is critical when dealing with a neurologic patient.
• Know what is normal!
• The three goals of the neurologic examination are to 1) determine if the patient has a neurologic problem, 2) localize the lesion, and 3) generate a short list of differential diagnoses.
• Useful tools for the neuro exam include: a quiet room, an experienced assistant, non-slip surface (i.e. yoga mat or other), reflex hammer, hemostats, cotton balls, penlight, lens, etc.
• There are eight basic areas to which a lesion may be localized: forebrain (including diencephalon), brainstem (midbrain, pons, medulla), cerebellum, cervical spinal cord, cervicothoracic spinal cord, thoracolumbar spinal cord, lumbosacral spinal cord, and neuromuscular. Remember that it is the location of the disease within the nervous system (not the disease) that determines the clinical signs.
• Please call Dr. Akin or Dr. Neary about any questions or cases you may have. We are eager to help!
References

• http://www.vetmed.wsu.edu/cliented/anatomy/nervous.aspx
• http://www.aisti.info/en/neurology/neurological_examination.html
• http://www.neuroanatomy.wisc.edu/SClinic/Weakness/Weakness.htm
• http://www.vetmed.wsu.edu/cliented/anatomy/nervous.aspx
Any questions?