

BRAIN ASSESSMENT AND DYSFUNCTION



BASICS

OVERVIEW

- Causative lesions can be localized using the principles outlined below
- Differential diagnoses are determined based on neuroanatomic localization, history, and signalment

PATHOPHYSIOLOGY

- Anatomic divisions of the central nervous system are:
 - *Forebrain* - Cerebrum plus rostral brainstem (diencephalon)
 - *Brainstem* - diencephalon, midbrain, pons, medulla
 - *Cerebellum*
 - *Cranial nerves* - I – olfactory; II – optic; III – oculomotor; IV – trochlear; Vs – trigeminal, sensory; Vm – trigeminal, motor; VI – abducens; VII – facial; VIII – vestibulocochlear; IX – glossopharyngeal; X – vagus; XI – spinal accessory; XII – hypoglossal
- Selected functional units of the central nervous system include:
 - *Upper motor neurons (UMN)* - Originate in the forebrain and brainstem and act within the CNS to regulate the function of other neurons. Through a series of feedback loops involving structures in the forebrain, brainstem, and cerebellum, UMN are involved in initiation and fine control of voluntary motor activity. Most importantly, UMN pathways originating from brainstem nuclei pass to lower motor neurons in the spinal cord to regulate muscle tone and posture of the trunk and limbs.
 - *General proprioception* - The sensory system that monitors the position and movement of the body and limbs. GP tracts bring proprioceptive information through the spinal cord from muscles, tendons, and joints and predominantly terminate in the cerebellum (spinocerebellar tracts). Relatively minor conscious GP pathways also relay GP information to the sensory (somesthetic) area of the cerebral cortex. Lesions of GP tracts cause ataxia.
 - *Vestibular system* - This special proprioceptive system maintains orientation of the animal against gravity. It comprises the sensory organ in the bony labyrinth of the petrous temporal bone, cranial nerve VIII, vestibular nuclei in the pons and medulla, and connections to the cerebellum, nuclei controlling eye movement (III, IV, VI), and to the LMN of the limbs via the vestibulospinal tracts.
 - *Reticular activating system (RAS)* - A network of neurons within the core of the brainstem (especially rostral brainstem) that receives all types of sensory input and functions to maintain the cerebral cortex in a wakeful state.

PHYSICAL EXAMINATION FINDINGS

Possible location(s) of lesions causing the indicated clinical signs is/are shown in parentheses

- Seizures (forebrain)

- Abnormal behavior (forebrain). May include compulsive walking and circling, head pressing, compulsive licking, hyperaggression (biting and charging), self-mutilation, mania, bellowing, neonatal maladjustment, hyperesthesia, and hyperresponsiveness.
- Reduced alertness (RAS, rostral brainstem). Levels include lethargy – dull but responds to normal stimuli; stupor – standing but only responds to strong stimuli; semi-coma – recumbent and only responds to strong stimuli; coma – unconscious and cannot be aroused
- Blindness – normal pupillary light reflex (PLR; forebrain); abnormal PLR (II, midbrain)
- Menace defect – with blindness (II, forebrain); without blindness (cerebellum, medulla, VII)
- Absent PLR – with blindness (II – midbrain); without blindness (III)
- Abnormal eye position (strabismus) – corrects with head positioning (vestibular nystagmus; VIII, mid-brainstem, cerebellum); not correctable (true nystagmus; III, IV, VI, mid-brainstem)
- Abnormal eye movements – spontaneous or positional nystagmus (VIII, mid-brainstem, cerebellum), absent physiologic nystagmus (VIII, mid-brainstem, cerebellum), tremors or oscillations (idiopathic)
- Reduced sensitivity to facial touching (hypoesthesia; Vs, brainstem, forebrain)
- Atrophy of chewing muscles, dropped jaw, deviated jaw (Vm, pons)
- Ear, eyelid, lip weakness, dry eye (VII, medulla)
- Head tilt, body lean and concavity, staggering gait (VIII, mid-brainstem, cerebellum)
- Head bob, intention tremor, limb hypermetria, delayed limb protraction, ataxia (cerebellum)
- Inability to swallow, incoordinated feed regurgitation, drooling saliva (IX, X, XI, medulla)
- Tongue weakness, atrophy, deviation (XII, medulla)
- Limb weakness and ataxia affecting thoracic and pelvic limbs (upper motor neurons to limbs arise from motor nuclei in mid to caudal brainstem; general proprioceptive tracts from the trunk and limbs pass to the cerebellum)

CAUSES AND RISK FACTORS

A list of more important causes by category follows. The species that are affected – C, cattle; S, sheep; G, goat; Ca, alpaca or llama, are indicated in parentheses. If all ruminants are affected there is no species indication.

- *Malformations* - Cerebellar hypoplasia/abiotrophy, hydrocephalus/hydranencephaly, meningoencephalocele, complex nervous system malformation, alpha mannosidosis (C), beta mannosidosis (G), hypomyelinogenesis (C,S), Doddler syndrome (C), maple syrup disease (C)
- *Injuries* - Sporadic, more common in neonates, small ruminants (e.g., thermal brain injury during disbudding of kids)
- *Inflammation* - Neonatal bacterial meningitis, listeriosis, brain abscess, pituitary abscess, rabies, pseudorabies (C,G), bovine herpesvirus encephalitis (BoHV-1, BoHV-5) (C), malignant catarrhal fever (C), otitis media/interna, thromboembolic meningoencephalitis (C), eastern equine encephalitis (Ca), louping ill (S,G), Borna disease (C,S), bovine spongiform encephalopathy (C), scrapie (S,G), focal symmetrical encephalomalacia (S,G), small ruminant lentiviruses (S,G), West Nile encephalitis (S,Ca), parelaphostrongylosis (G,Ca), coenurosis (S,G), setariasis (S,G), neosporosis (C)
- *Degeneration (metabolic and toxic)* - polioencephalomalacia, sulfur toxicity, lead poisoning (C), salt/water intoxication, nervous ketosis (C), vitamin A deficiency (C), hepatic encephalopathy, urea toxicity (C), nervous coccidiosis (C), tremorgenic mycotoxicoes, pregnancy toxemia (S,G)
- *Neoplasia*- BLV-induced lymphosarcoma does not occur intracranially. Metastatic and primary brain tumors rare.



DIAGNOSIS

- Assess behavior and level of consciousness before handling animal. Note abnormal behavior or seizure activity (forebrain) or reduced alertness (RAS in rostral brainstem)
- Examine cranial nerve function as follows:
 - Use hand to provoke eyelid closures (menace responses; II, central pathways, VII)
 - Assess pupil symmetry and PLR(II, rostral brainstem, III)
 - Look for abnormal nystagmus in neutral and extended head positions, noting direction of fast phase; elicit normal nystagmus by moving head side-to-side (VIII, medulla, cerebellum)
 - Assess position of eyeballs within bony orbits. Vestibular strabismus if eye deviations resolved by rotation of the head, true strabismus if uncorrectable (III, IV, VI, mid-brainstem)
 - Look for impaired ear movement, and ear, eyelid and lip drooping (VII, medulla); corneal ulceration from exposure (VII to orbicularis oculi) and/or dry eye (VII to lacrimal glands)
 - Elicit blink by touch below and above eye (palpebral reflex; V, mid-brainstem, VII)
 - Assess reaction to touching nasal septum (V, brainstem, forebrain)
 - Withdraw tongue and assess size and strength (XII, medulla)
 - Assess swallow (IX, X, medulla) by looking for drooling, or regurgitated ingesta. Test ability to swallow esophageal tube
- Examine gait (brainstem)
- Hopping – in small, cooperative animals hold up a limb and push the animal laterally to hop on the opposite limb (brainstem, cerebellum). Camelids usually push if hopping attempted

DIFFERENTIAL DIAGNOSES

- Brain disorders may be classified according to the MIIND system - malformation, injury, inflammation, neoplasia, and degeneration as described in *Causes and Risk Factors*

CBC/BIOCHEMISTRY/URINALYSIS

- Nonspecific

OTHER LABORATORY TESTS

- CSF analysis
 - CSF is usually collected from the lumbosacral site of ruminants; the atlantooccipital site can be used in highly obtunded or anesthetized patients
 - The approximate needle insertion site is at the intersection of a line connecting the caudal aspects of the tuber coxae and the midline. The precise location is a palpable depression between L6 and S2. After sterile preparation, block the site with up to 1 mL of local anesthetic. Insert a needle perpendicular to the skin until there is a slight reduction in resistance to insertion, twitch of the tail, or other reaction from the patient. CSF may appear at the needle hub but usually needs to be aspirated by gentle negative pressure. Appropriate needles are 1-inch 20-ga for lambs and kids, 1-inch 18-ga for neonatal calves, and 3.5-inch styleted 18-ga needle for adult cows.

- CSF should be clear and colorless. May be turbid in bacterial meningitis
- Protein concentration < 40 mg/dL (some sources $\leq$ 70 mg/dL). High concentrations occur in inflammatory diseases and during active degeneration (e.g., acute polioencephalomalacia)
- Total nucleated cell count <10/ μ L, ~ half lymphocytes and half macrophages. Typically, cell counts are high in inflammatory diseases; neutrophilic in extracellular bacterial diseases, mononuclear phagocytic in viral diseases, listeriosis, and salt toxicity, and broadly granulocytic in parasitic encephalitides
- RBC count < 100/ μ L. High counts are usually caused by contamination during collection but may also may be caused by trauma.

IMAGING

- Radiography – most relevant to skull trauma
- Cross-sectional imaging (CT, MRI) - excellent tool for diagnosis of malformations
- Ultrasonography - Brain can be imaged through open fontanelle of calves and through skull of small ruminant neonates.

OTHER DIAGNOSTIC PROCEDURES

- N/A



TREATMENT

See specific disorders



MISCELLANEOUS

ABBREVIATIONS

PLR – Pupillary light reflexes
 CSF – cerebrospinal fluid
 UMN – Upper motor neurons
 RAS – reticular activating system

SUGGESTED READING

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