Neurological Emergencies Mini Series

Session Two - Acute disorders the Head and Face - vestibular disease and the other cranial nerves

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VESTIBULAR DISEASE IN DOGS AND CATS

The vestibular system is essential in maintaining balance and preventing the animal falling over by keeping and adapting the position of the eyes, head and body with respect to gravity. It is therefore not surprising that disease of the vestibular system results in some of the most dramatic and distressing neurological signs. Head tilt, falling, rolling, leaning, circling, abnormal nystagmus and ataxia commonly result. Clinical signs of vestibular disease may be a result of lesions involving either the receptor organs in the inner ear or the vestibular portion of the eighth cranial nerve (i.e., peripheral vestibular disease) or lesions involving the brainstem vestibular nuclei or vestibular centers in the cerebellum (i.e., central vestibular disease). This session reviews the clinical approach of an animal with a vestibular disorder.

VESTIBULAR DISORDERS: CLINICAL SIGNS

Vestibular disorders (VD) are common in dogs and cats and may result in any or all of the following clinical signs: head tilt, falling, rolling, leaning, circling, abnormal nystagmus, positional strabismus, and ataxia.

- **Head tilt** often indicates a VD. This abnormal head posture is characterized by a rotation of the median plane of the head (one ear is held lower than the other). It occurs in VD as a result of the loss of antigravity muscle tone on one side of the neck. It must be differentiated from a head turn where the median plane of the head remains perpendicular to the ground but the nose is turned to one side. Such head turn is usually associated with a body turn. A head turn does not indicate a vestibular disorder and is usually toward the side of a forebrain lesion.
- **Circling** may occur in conjunction with VD as well as an asymmetrical or focal lesion in the forebrain. Tight circles are usually but not exclusively associated with a VD, while wide circles are often associated with a forebrain lesion.
- **Nystagmus** is an involuntary rhythmic movement of the eyeballs. Physiologic nystagmus is nystagmus that occurs in normal animals while pathologic nystagmus reflects an underlying VD. The direction of the nystagmus is typically defined by the direction of the fast phase. Physiologic nystagmus can be induced in the normal animal by rotating the head from side to side (oculo-vestibular reflex). It is characterized by a slow phase in the opposite direction of the head movement and a fast compensatory phase in the same direction as the head rotation. Physiologic nystagmus can be depressed in animal with unilateral VD or absent in animal with bilateral VD. Pathologic nystagmus can be either spontaneous (observed when the head is in a normal position at rest) and/or positional (that which occurs, or is altered in character, intensity or direction, with alteration in the position of the head, for example by placing the animal upside down on its back). Nystagmus is usually classified on the basis of its direction and may be horizontal, vertical or rotatory and may change in direction on changing position of the head. The fast phase of pathologic nystagmus is typically directed away from the side of the vestibular lesion.
- **Strabismus** refers to an abnormal position of the globes. Strabismus can be seen in VD when the head is placed in an abnormal position (extended dorsally or the animal placed upside down on its back). VD often causes a ventral or ventrolateral positional strabismus in the eye on the same side as the vestibular lesion.
- **Ataxia** is defined as an uncoordinated gait and can be caused by a vestibular disorder (vestibular ataxia), a cerebellar disorder (cerebellar ataxia) or a peripheral nerve, spinal cord or brainstem disorder (proprioceptive or sensory ataxia). Vestibular lesions often cause ataxia characterized by swaying of the trunk and head, base-wide stance, leaning, falling and rolling to one side with unilateral lesion. With bilateral VD, affected animals tend to fall to both sides and often show wide excursion of the head from side to side.

VESTIBULAR DISORDERS: LOCALIZING THE LESION

Clinical signs of VD may be a result of lesions involving the receptor organs in the inner ear or the vestibular portion of the eighth cranial nerve running in the petrous part of the temporal bone (i.e., peripheral VD) or lesions involving the brainstem vestibular nuclei (i.e., central VD).

- **Peripheral or central?**

Most lesions affect a region, rather than a specific nerve or nucleus, so accompanying neurologic abnormalities can often be used to localize the lesion to the peripheral or central vestibular system (Table 1). Both peripheral and central VD can cause a head tilt, horizontal or rotatory nystagmus, and ataxia.

Facial paralysis and Horner's syndrome can be seen with peripheral VD due to the proximity of cranial nerve VII (facial nerve) and the sympathetic nerve supply to the eye to the vestibular nerve in the region of the petrous temporal bone. Correctly identifying central VD requires identification of clinical signs that cannot be attributed to diseases of the peripheral vestibular system. Lesions that affect the central vestibular system typically have additional clinical signs suggestive of brainstem involvement. Such lesions often involve the reticular formation as well as ascending and descending motor and sensory pathways to the ipsilateral limbs. Therefore, abnormal mental status, ipsilateral paresis, and conscious proprioceptive deficits are commonly associated with central VD. Deficits of cranial nerves V through XII can also be associated with central VD. The presence of spontaneous or positional jerk nystagmus indicates vestibular dysfunction but does not further localize the lesion to the peripheral or central vestibular system. However, vertical nystagmus and nystagmus that changes in direction on changing position of the head are a feature of central vestibular lesions. Rate of nystagmus (number of beats per minute with the head in a neutral position as well as with the animal in dorsal recumbency) can further assist with differentiation between central VD from peripheral VD. Median rate of resting and positional nystagmus appears to be significantly faster for dogs with peripheral VD with a resting nystagmus ≥ 66 beats per minute providing the highest combined sensitivity and specificity in diagnosing peripheral VD. With peripheral and central VD, the head is usually tilted in the direction of the lesion. With paradoxical VD, however, the head is usually tilted opposite to the direction of the lesion.

	Peripheral	**Central**
Head tilt	Ipsilateral	Ipsilateral (or contralateral in case of paradoxical VD)
Asymmetrical ataxia	Ipsilateral	Ipsilateral
Nystagmus • Horizontal • Rotatory • Vertical • Positional	 Ipsilateral Ipsilateral No No (except during the early phase of recovery)	 Ipsilateral or contralateral Ipsilateral or contralateral Yes Yes
Postural reaction deficit	No	Yes (always ipsilateral to the lesion)
Abnormal mental status	No	Possible
Circling	Ipsilateral	Ipsilateral or contralateral

Table 1. Clinical findings associated with peripheral and central vestibular disease

Occasionally, intracranial lesions can result in signs suggestive of a peripheral lesion. Although animals with a peripheral VD have a normal level of consciousness and no evidence of weakness or postural reaction deficits, the absence of these signs does not rule-out the presence of a central VD. If in doubt about the localization of the lesion, the clinician should evaluate the animal for central VD as well as peripheral VD. In very rare cases, VD may be part of a diffuse polyneuropathy or cranial polyneuropathy. Other cranial nerve dysfunction such as dysphagia, tongue weakness, jaw weakness and/or facial paralysis as well as limb weakness with depressed segmental spinal reflexes may be seen. Note also that lesions of the thalamus and/or extrapyramidal basal nuclei may also cause abnormal head posture and signs of central VD.

- **Ipsilateral, contralateral or bilateral lesion?**

With both central and peripheral VD, the head tilt, circling and nystagmus typically occur ipsilateral to the side of the lesion. Less frequently, lesions affecting the caudal cerebellar peduncle, the fastigial nucleus, or the flocculonodular lobes of the cerebellum can cause central VD with a resulting paradoxical head tilt. This syndrome is called paradoxical because the head tilt and circling occur contralateral to the side of the lesion. Bilateral VD is characterized by head sway from side to side, loss of balance on both sides and symmetrical ataxia with a wide-based stance. A physiological nystagmus usually cannot be elicited and a head tilt is not observed.

DIFFERENTIAL DIAGNOSIS OF VETSIBULAR DISORDERS

A lesion must be localized to a particular section of the vestibular apparatus before an appropriate differential diagnosis can be established and further test conducted. The formation of a differential diagnosis list is essential in choosing and interpreting any diagnostic test. Diseases affecting the nervous system are classically classified in disease processes using the mnemonic VITAMIN D.

Disease mechanism	**Peripheral vestibular disease**	**Central vestibular disease**
Vascular		Brain infarct Brain hemorrhage
Inflammatory/ **I**nfectious	Otitis media/interna Nasopharyngeal polyps	Infectious encephalitis (Distemper, Toxoplasma, Neospora, Fungus, Bacterial, FIP) Meningo-encephalitis of unknown etiology (GME, necrotizing, idiopathic)
Trauma	Head trauma	Head trauma
Toxic	Aminoglycosides, topical chlorhexidine	Metronidazole
Anomalous	Congenital vestibular disease	Intracranial intra-arachnoid cyst, dermoid/epidermoid cyst, Dandy-Walker syndrome, Chiari-like malformation
Metabolic	Hypothyroidism	
Idiopathic	Idiopathic vestibular disease	
Neoplastic	Middle and/or inner ear tumour	Primary or metastatic brain tumor
Nutritional		Thiamine deficiency
Degenerative		Neurodegenerative disease

Idiopathic vestibular syndrome is common in adult cats and dogs (often geriatric). Clinical signs are usually peracute and initially severe with affected animal appearing extremely disable in the first 48 to 72 hours. If facial nerve paralysis or Horner's syndrome (miosis, enophthalmia, protrusion of third eyelid, ptosis of upper eyelid) is also present then other differentials should be considered. Diagnosis is based on the presence of compatible history and exclusion of other causes of peripheral VD. Most animals tend to improve over 1 to 3 weeks period and often return to normal. However, some animal may be left with a permanent head tilt or episodic ataxia. No treatment has proved beneficial and recurrence is possible.

Otitis media/interna can be secondary to otitis externa, oropharyngeal infection (spreading via the auditory tube) or hematogenous spreading. Therefore, the absence of sign of otitis externa does not rule-out the presence of otitis media/interna. Clinical course can be acute or progressive. Signs of VD caused by otitis media/interna are often associated with ipsilateral facial nerve paralysis and/or Horner's syndrome. Diagnosis is made by otoscopic examination and imaging studies (bulla radiographs, CT or MR scan) and/or exclusion of other causes of peripheral VD. If fluid is visualized within the middle ear then attempt should be made to obtain a sample via myringotomy for cytology and bacterial culture. Treatment of otitis media/interna consists of systemic antibiotic for a minimum of four to six weeks (oral amoxicillin/clavulanate, fluoroquinolone or cephalosporin if no culture can be obtained following myringotomy). Surgical drainage and debridement via bulla osteotomy should be considered in case of failure of medical treatment. Prognosis is guarded to fair as some animal may be left with permanent head tilt and/or facial paralysis.

Tumors of the caudal fossa and meningo-encephalitis of unknown etiology (MUE) such as granulomatous meningo-encephalitis (GME) are the two most common causes of central VD.

Common types of tumors found in the caudal fossa include meningioma and choroid plexus tumor both which have a tendency to arise at the level of the emergence of the vestibulo-cochlear nerve at the cerebellomedullary angle. Less common tumors include glioma, ependymoma or medulloblastoma. Signs of VD associated with these tumors are often slowly progressive. Presumptive diagnosis is made

by advance imaging (CT or MRI) but the exact type of tumor can only be confirmed histologically (either by surgical tissue biopsy or post-mortem). Prognosis is fair for surgically accessible cerebellomedullary angle meningioma. Prognosis is more guarded for other tumors.

Meningo-encephalitis of unknown etiology (MUE) is often attributed to GME, the diagnosis of which can only be confirmed on histopathology. Clinical signs can be acute or progressive in onset. Neurolocalisation often suggests multifocal involvement but can occasionally be focal. A presumptive diagnosis can be made based on a consistent history, clinical signs, signalment (frequently young to middle-aged female terrier breeds), multifocal, contrast-enhancing lesions on MRI, CSF analysis (pure mononuclear pleocytosis or a mixed cell population) and exclusion of infectious aetiologies on serological or PCR tests (mostly Distemper, Toxoplasma and Neospora). Immunosuppressive doses of corticosteroids have been the mainstay of treatment for presumptive GME. Other immunomodulatory drugs such as azathioprine, procarbazine, cytosine arabinoside and cyclosporine as sole agent or as an adjunctive treatment with prednisone have been reported to be effective in some dogs. Overall, the prognosis is guarded but survival times range from weeks to years.

NEURODIAGNOSTIC INVESTIGATIONS OF VESTIBULAR DISORDER

The choice of neurodiagnostic tests in patient with VD depend essentially on where the lesion is suspected on the basis of the neurological examination. If in doubt about the localization of the lesion, the animal should be evaluated for both peripheral and central VD.

- **Peripheral Vestibular Disease**

Diagnostic plan for patients with signs suggestive of peripheral VD include at least otoscopic and pharyngeal examination, imaging of the tympanic bullae with radiographs, computed tomography (CT) or magnetic resonance imaging (MRI) and thyroid function testing. Middle ear pathology should be suspected if the tympanic membrane is ruptured, bulging, cloudy or red in color on otoscopy. If the tympanic membrane is ruptured, swabs for cytology and culture (aerobic, fungal and yeast) can be taken directly from the middle ear. If the tympanic membrane is intact but bulging or of an abnormal colour, a small hole (myringotomy) can be made in the tympanic membrane with a 20-gauge spinal needle to obtain samples for cytology and culture. Additionally, the middle ear cavity can be flushed by attaching a 10 to 20 cc syringe of warm saline to the spinal needle. Warm water is flushed into the tympanic cavity and gently suctioned. The resulting fluid can then be submitted for cytology and culture. Radiographic evaluation of the tympanic bullae requires general anesthesia to allow adequate positioning. Four radiographic projections are classically used (dorsoventral, latero-lateral, latero 20° ventral-laterodorsal and rostro 30° ventral-caudodorsal open-mouth projection). Although positive radiographs can be seen as highly specific in the diagnosis of middle ear disease, negative radiographs do not rule out the presence of middle ear disease. CT and MRI are more sensitive than radiographs in detecting middle ear pathology. Brainstem auditory evoked response test may be abnormal if the cochlea, vestibulocochlear nerve or auditory brainstem pathways are involved and can sometime be used to differentiate central from peripheral VD. Finally, electromyography (EMG) and motor nerve conduction study are indicated in patients suspected of multiple cranial nerve neuropathy or of a more diffuse polyneuropathy.

- **Central Vestibular Disease**

Evaluation of patients suspected of central VD include in first instance the use of advance imaging (CT or MRI), cerebrospinal fluid (CSF) analysis (nucleated cell count and cytology, total protein concentration), serum and CSF titers (serology and/or PCR) for various infectious organisms (toxoplasma gondii, neospora caninum, canine distemper, coronavirus, fungal agents...). Further investigations may be require in cases suspected of brain tumour (tissue biopsy by surgical or stereotactic biopsy, thoracic and abdominal imaging to investigate metastatic disease), thiamine deficiency (urinary organic acids excretion screening or transketolase activity in fresh erythrocytes) or cerebrovascular accident (routine hematology and serum biochemistry, clotting profile, evaluation of arterial blood pressure, thyroid, kidney, adrenal and heart function).

CRANIAL NEUROPATHIES AND MYOPATHIES

CLINICAL SIGNS OF CRANIAL NEUROPATHIES AND MYOPATHIES

- **Blindness**
- **Anisocoria**
- **Strabismus**
- **Jaw paralysis**
- **Temporalis and masseter muscle atrophy**
- **Facial paralysis**
- **Deafness**
- **Dysphagia**
- **Megaesophagus**
- **Stridor**
- **Dysphonia**
- **Tongue paralysis**
- **Combination of above signs**

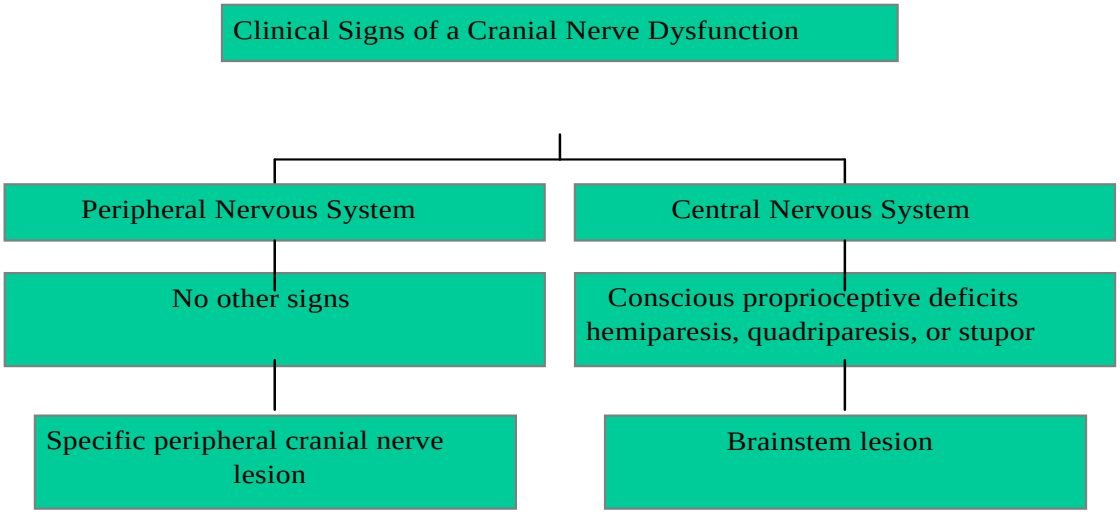
DEFINITIONS

- **Anisocoria**- unequal pupil size
- **Strabismus**- unilateral or bilateral deviation of the eye(s) due to paralysis of one or more of the extraocular muscles
- **Mydriasis-** dilated pupil associated with fear or a lesion of the oculomotor nerve
- **Miosis-** constricted pupil associated with a lesion of the sympathetic innervation to the eye.
- **Ptosis-** paresis of the levator muscles of the eyelid causing the eyelid to droop thereby reducing the size of the palpebral fissure; associated with a lesion of the oculomotor nerve (CN 3) or sympathetic innervation of the eye.
- **Enophthalmos-** a backward displacement of the eyeball into the orbit that induces a passive elevation of the third eyelid and a slight reduction in the diameter of the palpebral fissure; associated with lesions of the sympathetic innervation of the eye.
- **Jaw paralysis-** inability to close the mouth
- **Facial paralysis**- inability to move the eyelid, lip or ear associated with dysfunction of the facial nerve (CN 7)
- **Keratitis sicca-** inflammation of the cornea associated with reduced or absent tear production
- **Dysphagia**- difficulty swallowing often associated with dysfunction of the glossopharyngeal (CN 9) or the vagus (CN 10) nerves
- **Megaesophagus**- enlarged esophagus with reduced or absent motility
- **Stridor-** a harsh high pitched respiratory sound often associated with inspiration in animals with laryngeal paresis or paralysis
- **Dysphonia-** a change in voice often associated with laryngeal paresis
- **Dysautonomia-** dysfunction of the autonomic nervous system

LESION LOCALIZATION

- The peripheral nervous system (PNS) portion of a cranial nerve
- The central nervous system (CNS)- brainstem portion of a cranial nerve
- The muscles of the head

DIFFERENTIATION OF A PERIPHERAL AND CENTRAL CRANIAL NERVE LESIONS



- **Peripheral nerve:** Only the cranial nerve deficits are present. The rest of the neurologic examination is normal unless the cranial neuropathy is part of a generalized peripheral nerve disease.
- **Central nervous system:** Cranial nerve signs plus dementia, stupor, unilateral or bilateral conscious proprioceptive deficits, ataxia, hemiparesis or quadriparesis. Cranial nerves enter or exit the brainstem in the medulla oblongata, pons, midbrain or diencephalon.
- **Muscle disease:** Pain on opening the mouth, atrophy and fibrosis of the muscles of mastication and inability to open the mouth due to muscle fibrosis; may be muscle disease isolated to the head or part of a generalized muscle disease.

DIFFERENTIAL DIAGNOSIS

Peripheral Nerve and Muscle Disorders

Blindness

1. Retinal diseases- (common dogs and cats)
2. SARDS- (common dogs and cats)
3. Optic neuritis- (occasional dogs)
4. Optic atrophy- (occasional dogs and cats)
5. Optic hypoplasia- (occasional dogs and cats)

Anisocoria

1. Idiopathic anisocoria- (occasional dogs, common cats)
2. Trauma to the cervical sympathetic nerve- (occasional dogs and cats)
3. Neoplasia affecting cervical sympathetic nerve- (occasional dogs and cats)
4. Neoplasia of oculomotor nerve (rare dogs and cats)

Strabismus

1. Trauma to the oculomotor, trochlear or abducens nerves- (common dogs and cats)
2. Congenital strabismus- (occasional dogs and cats)
3. Neoplasia affecting oculomotor, trochlear or abducens nerves- (rare dogs and cats)
4. Extraocular myositis- (rare dogs and cats)

Jaw paralysis

1. Idiopathic trigeminal neuropathy- (common dogs)
2. Bilateral trauma to the trigeminal nerves- (occasional dogs and cats)

Temporalis and masseter muscle atrophy

1. Masticatory myositis- (common dogs)
2. Trigeminal nerve trauma- (occasional dogs and cats)
3. Neoplasia affecting the trigeminal nerve- (rare dogs and cats)

Facial paralysis

1. Otitis media or interna- (common dogs and cats)
2. Idiopathic facial paralysis- (common dogs)
3. Facial nerve trauma- (common dogs and cats)
4. Hypothyroidism- (occasional dogs)
5. Myasthenia gravis- (occasional dogs and cats)
6. Neoplasia affecting the facial nerve- (rare dogs and cats)

Deafness

1. Otitis media or interna- (common dogs and cats)
2. Senile degeneration - (common dogs and cats)
3. Congenital deafness - (occasional dogs and cats)

4. Aminoglycoside intoxication – (occasional dogs and cats)

Dysphagia, Megaesophagus, Stridor or Dysphonia

1. Idiopathic megaesophagus - (common dogs)
2. Idiopathic laryngeal paresis or paralysis - (occasional dogs and cats)
3. Trauma to vagus nerves - (occasional dogs and cats)
4. Polymyositis- (occasional dogs and cats)
5. Hypothyroidism - (occasional dogs)
6. Myasthenia gravis - (occasional dogs and cats)
7. Polyneuropathy - (occasional dogs, rare-cats)
8. Neoplasia affecting the vagus nerve - (rare dogs and cats)

Tongue paralysis

1. Trauma to the hypoglossal nerve - (rare dogs and cats)
2. Neoplasia affecting the hypoglossal nerve - (rare dogs and cats)
3. Polyneuropathy - (rare dogs and cats)

Multiple cranial nerve signs

1. Cranial polyneuropathy - (rare dogs and cats)
2. Dysautonomia - (rare dogs and cats)

Central Nervous System Disorders (Any cranial nerve sign)

1. Meningoencephalitis- (common dogs and cats)
2. Trauma- (common dogs and cats)
3. Cerebrovascular disorders- (occasional dogs and cats)
4. Neoplasia- (common dogs and cats)

Important Historical Questions

- Date of onset?
- Acute or chronic? Non-progressive or progressive?
- How is vision? Difference in day or night?
- How is hearing?
- Is there a change in the appearance of the face?
- Is there any difficulty drinking, eating, chewing or swallowing?
- Is there regurgitation?
- Any weakness of the limbs?
- Seizures, dementia, head tilt or other neurological signs?
- Possibility of trauma?
- Concurrent or past illness?
- Concurrent or past neoplastic disease?

- Recent or current medications, nutritional supplements or exposure to intoxicants?

Physical Examination

- Examination of the ocular fundus for evidence of chorioretinitis or other retinal disease
- Examine ears for evidence of otitis externa
- Examine body for evidence of systemic disease

Neurologic Examination

- Determine which cranial nerve(s) or muscles are involved
- Determine if a peripheral or central nervous system lesion is present

Applicable Diagnostic Tests

- A complete blood count (CBC), serum chemistry profile and urinalysis are performed to detect systemic illness and as part of the pre-anesthetic evaluation.
- Chest and abdomen radiographs with or without abdominal ultrasound may be evaluated to check for megaesophagus, aspiration pneumonia and evidence of neoplasia.
- An electroretinogram (ERG) can differentiate retinal degeneration from optic neuritis
- A serum thyroxine (T4) level may be reduced and a thyroid stimulating hormone (TSH) level elevated with hypothyroidism.
- A serum CK may be elevated with myositis.
- A serum acetylcholine receptor (AChR) antibody is often elevated in animals with myasthenia gravis.
- A serum creatine kinase (CK) may be elevated in animals with polymyositis
- A serum 2M-antibody level is often elevated in dogs with masticatory myositis.
- The following tests are performed under general anesthesia:
    - An electromyogram (EMG) can be useful to determine if there are lesions in more than one cranial nerve or if a diffuse polyneuropathy or polymyopathy or myasthenia gravis is present.
    - A brainstem auditory evoked response (BAER) is used to evaluate hearing and brainstem integrity.
    - Computed tomography (CT) or magnetic resonance (MR) imaging can be abnormal in cases of retrobulbar and ocular disease, inner ear infection and neoplasia, meningoencephalitis, brainstem neoplasia and trauma.
    - The cerebrospinal fluid (CSF) analysis is often abnormal in cases of meningoencephalitis or neoplasia.
    - A biopsy of the temporalis and masseter muscles will show inflammation and necrosis in cases of masticatory myositis.

Blindness

Visual deficits with dilated pupils that do not respond to light are usually associated with diseases of the retina and optic nerves (CN 2). Chorioretinitis, retinal detachment and some forms of retinal degeneration can be visualized on funduscopic examination. Chorioretinitis may be associated with viral, protozoal, fungal, rickettsial and other infections as well as granulomatous meningoencephalitis (see lecture 9). Severe chorioretinitis can result in retinal detachment. Retinal detachment may also be due to immune-mediated, inherited, neoplastic or idiopathic disorders and systemic hypertension. Retinal degeneration is a common cause of blindness in dogs but can occur in cats as well. Progressive retinal atrophy is usually inherited. Other causes of retinal degeneration are taurine deficiency of cats, enrofloxacin toxicity in cats, vitamin E deficiency and glaucoma.

Sudden blindness in dogs with a normal ocular fundus but absent pupillary light reflexes could be due to sudden acquired retinal degeneration (SARDS), optic neuritis or a toxic optic neuropathy. Some cases of optic neuritis show swelling of the optic disk but the optic disk may also appear normal. Since toxic optic neuropathies have been described in man all recent or current medications, nutritional supplements, or exposure to toxic substances should be considered for the potential of neurotoxicity and discontinued if possible. The electroretinogram (ERG) is abnormal in animals with SARDS but not in optic neuritis and differentiation of these two diseases is essential as early diagnosis and treatment of optic neuritis may restore vision. There is no effective treatment for SARDS and it appears to be a sudden photoreceptor cell death of unknown cause with no associated inflammation.

Optic neuritis may be associated with an infectious agent such as canine distemper virus, feline infectious peritonitis virus, *toxoplasma gondii*, and some fungi, granulomatous meningoencephalitis, a paraneoplastic syndrome, trauma, immue-mediated or can be idiopathic. Any enlarged lymph nodes should be aspirated ot detect infection or neoplasia. CSF analysis, serum and CSF organism immunoassays and MR imaging may be useful to rule out a concurrent meningoencephalitis or neoplasia. Treatment of meningoencephalitis is found in lecture 9. A thorough examination for neoplasia elsewhere in the body should be performed. If other causes are ruled out then a diagnosis of idiopathic optic neuritis is made. Since idiopathic optic neuritis is suspected to be immune-mediated, immunosuppressive drugs are given.

Treatment with oral prednisone 1-2mg/kg every 12 hours for 2-3 weeks with subsequent tapering of the dose often improves vision. Oral famotidine (Pepcid AC) 0.5-1 mg/kg every 12-24 hours, cimetidine (Tagamet) 5-10 mg/kg every 12 hours or misoprostol (Cytotec) 1-3 µg/kg every 8 hours are recommended to protect the gastrointesinal tract from upset or ulcers when administering steroids at high doses.

If there is no response to prednisone alone, the anti-neoplastic immunosuppressive drug procarbazine (Matulene) may be given at 2-4 mg/kg/day for 1 week then increased to 4-6 mg/kg/day. The hemogram and platelet count should be monitored every week initially. If the leukocyte count falls below 4000 cells/µl or platelets are less than 100,000 cells/µl, the drug is discontinued until the leukocyte count returns to normal. Therapy may have to be given for 6-12 months to control clinical signs. Periodic drug withdrawal may be used to see if a relapse of visual deficits occurs. In some cases blindness may be permanent.

If small optic nerves are visualized on funduscopic examination of an animal with reduced or absent vision and reduced or absent pupillary light reflexes then optic nerve atrophy from a previous optic neuritis, trauma, retrobulbar inflammation or compression, glaucoma or end stage retinal degeneration are considered. Optic nerve hypoplasia may cause congenital blindness with absent pupillary light reflexes.

Anisocoria

Anisocoria with normal vision and no other ophthalmologic or neurologic signs may be due to a lesion of the parasympathetic portion of the oculomotor nerve (CN 3) or the sympathetic innervation of the eye.

The sympathetic innervation of the eye is a complex pathway involving three neurons. The first neuron begins in the hypothalamus and descends through the brainstem and cervical spinal cord to the T2 region. A second neuron exits the spinal cord at T2, passes through the thoracic inlet traveling cranially with the descending vagus nerve forming the peripheral vagosympathetic nerve. It synapses with a third neuron at the superior cervical ganglion in the high cervical region. The third neuron goes through the middle ear and into the retrobulbar region to innervate the eye. Lack of parasympathetic innervation causes mydriasis Lack of sympathetic innervation to the eye causes a Horner's syndrome (ptosis, miosis and enophthalmos).

When an animal is presented with anisocoria, the challenge is to determine which is the abnormal eye, the one with the larger or smaller pupil. If vision is normal, the pupil is enlarged, and the direct and consensual pupillary light reflexes are absent then an oculomotor nerve lesion is likely. A small pupil that fails to dilate in a darkened room is typical of a sympathetic nerve lesion. Idiopathic anisocoria, with spontaneous resolution is common in cats and may also occur in dogs but other causes should be ruled out.

Unilateral oculomotor nerve paralysis may be associated with head trauma and neoplasia. CT or MR imaging of the midbrain area should be considered. Neurofibroma, meningioma, and lymphosarcoma of the oculomotor nerve may occur as it exits the brainstem. Neoplasia in this region is very difficult to remove. Horner's syndrome with no other neurologic signs is usually associated with trauma or neoplasia affecting the vagosympathetic nerve. Thoracic radiographs may reveal as mass in the thoracic inlet. Horner's syndrome may be associated with inner ear infections, brainstem or cervical spinal cord disorders and with paralysis of the thoracic limb. Retrobulbar masses may also cause anisocoria and affect either sympathetic or parasympathetic innervation to the pupil or both.

Strabismus

Ventrolateral strabismus may be due to a lesion of the oculomotor nerve (CN 3), while medial strabismus is usually associated with an abducens nerve (CN 6) lesion. Dysfunction of the trochlear nerve (CN 4) is rare in dogs and cats. Congenital strabismus can be seen in dogs and cats. Differential diagnosis in older animals includes trauma and neoplasia. Strabismus with no other neurologic signs may be due to trauma or neoplasia of the associated peripheral nerve. CT or MR imaging should be considered if mass lesions of the orbit or cranial nerves are suspected. Neurofibroma or lymphosarcoma of the oculomotor or abducens nerves can occur and are difficult to remove when they are close to the brainstem. Retrobulbar masses may cause deviation of the eyeball. Focal extra ocular myositis and fibrosis can result in strabismus in Chinese Shar Peis and other dogs but is rare.

Jaw paralysis / Dropped Jaw

A syndrome of acute paralysis of the masticatory musculature occurs in dogs and is manifested by an inability to close the mouth (jaw paralysis). The cause is unknown but neuritis of the trigeminal nerves (CN 5) is suspected. Some dogs also have unilateral or bilateral Horner's syndrome. Most dogs are able to ingest a high calorie blended liquid food or gruel and water to maintain nutrition and hydration. A few dogs may benefit from gastrostomy tube feeding. **Treatment with oral prednisone 1-2 mg/kg for 1 week then tapered may hasten recovery but most dogs recover in a few weeks even without prednisone therapy.** Oral famotidine (Pepcid AC) 0.5-1 mg/kg every 12-24 hours, cimetidine (Tagamet) 5-10 mg/kg every 12 hours or misoprostol (Cytotec) 1-3 µg/kg every 8 hours may be given to protect the gastrointestinal tract from irritation if corticosteroids are administered. Jaw paralysis can also occur from bilateral trauma to the trigeminal nerves, which usually resolves without treatment.

Temporalis and masseter muscle atrophy

Masticatory myositis is an immune-mediated disease of dogs characterized acutely by pain opening the mouth and muscle swelling and chronically by atrophy of the temporalis and masseter muscle and inability to open the mouth due to muscle fibrosis. The immune mediated response is directed toward the 2M type fibers of the masticatory muscles. Elevated 2M antibody levels may be found in the serum of affected dogs. Inflammation and fibrosis are seen on histological examination of a muscle biopsy. In case where only pain opening the mouth is present retrobulbar or temporomandibular joint disorders should also be considered.

If masticatory myositis is confirmed, oral prednisone 1-2 mg/kg every 12 hours is given until jaw mobility returns. The dosage is then be gradually tapered to the level necessary to maintain mobility. Oral famotidine (Pepcid AC) 5 mg/kg/day, cimetidine (Tagamet) 5-10 mg/kg every 12 hours or misoprostol (Cytotec) 1-3 µg/kg every 8 hours may reduce gastrointestinal irritation when the dose of steroid therapy is high. If there is no response to prednisone alone then other immunosuppressive drugs may be considered. Oral azathioprine (Imuran) 2 mg/kg once daily may be added to the prednisone therapy until improvement is seen and then reduced to every other day dosage indefinitely. Hemograms and platelets counts should be closely monitored. Supportive care consists of feeding blended food or gruel and water. Recurrences are common and alternate day prednisone therapy may be required indefinitely to control the disease.

Early diagnosis and treatment are essential as chronic myositis can lead to severe muscle fibrosis and an inability to open the mouth making eating and drinking impossible. Forceful opening of the jaw under anesthesia or surgical excision of fibrosis around the temporomandibular joint may temporarily open the mouth but the jaw hangs open following surgery and fibroses usually recurs.

On rare occasions masticatory myositis may be asymmetrical but more often unilateral atrophy of the temporalis and masseter muscles is due to a traumatic, inflammatory or neoplastic disease process affecting the trigeminal nerve (CN 5).

Facial nerve paralysis

Facial nerve paralysis results in an inability to move the eyelid, ear or lip one or both sides. Acutely the ear and the lip on the affected side may be flaccid and hang below the normal side. In chronic paralysis muscle fibrosis causes the lip and ear to contract and be carried higher than the normal side. The inability to close the eyelid is usually obvious on the affected side. The facial nerves innervate the lacrimal and salivary glands and lesions may cause dryness of the eyes and mouth. Food may collect inside the lips on the affected side. The Schirmer's tear test can be useful to evaluate tear production. Administration of artificial tears in the affected eye 3-4 times daily may be needed to prevent keratitis sicca and corneal ulceration.

Otitis media commonly causes facial paralysis with no other signs especially in dogs with chronic otitis externa. Otitis media and interna may also cause facial paralysis with Horner's syndrome and vestibular signs.

Trauma to the facial nerve can cause facial nerve paralysis, which often resolves in time. Hypothyroidism may cause facial paralysis. A microcytic anemia and elevated cholesterol may be found on the CBC and chemistry profile respectively but hypothyroidism is best diagnosed by demonstrating a low serum total T4 or free T4 level in conjunction with an elevated TSH. **Oral levothyroxine sodium (Soloxine) 0.02 mg/kg every 12 hours usually results in a resolution of signs**.

An EMG can be evaluated to determine if the facial paralysis is focal or part of a multifocal cranial polyneuropathy.

Idiopathic facial nerve paralysis is a diagnosis made by ruling out other disease processes and is more common in dogs especially Cocker Spaniels than in cats. Recovery often occurs in 4-6 weeks without specific therapy although the paralysis is permanent in some cases.

Deafness

Deafness is associated with bilateral disease of the sensory receptors of the cochlea within the inner ear and the cochlear nerves (CN 8). Congenital deafness may be an inherited disorder in many breeds of dogs particularly Dalmatians and other breeds with white hair coats and light colored eyes. Blue-eyed white cats are also usually deaf at birth. Puppies and kittens can have their hearing tested 6 –8 weeks of age using a brainstem auditory evoked response (BAER) test. The BAER can test hearing in each ear individually and detect unilateral deafness, which is important information to obtain for breeding programs. Congenital deafness is usually occurs because of a lack of development of the receptor organs of the inner ear necessary for hearing and there is no treatment.

Any dog or cat with hearing problems should be carefully evaluated for otitis interna as early diagnosis and treatment may resolve the hearing loss. The diagnosis and treatment of otitis interna is found in lecture 7. Aminoglycoside antibiotic intoxication can cause deafness in dogs and cats especially amikacin, kanamycin and tobramycin so animals receiving these drugs should have their hearing monitored. Senile degeneration of the inner ear structures may occur with age. The use of hearing aid devises have been attempted but most animals will not tolerate them.

Dysphagia, Megaesophagus, Dysphonia and Stridor

Dysphagia, megaesophagus, dysphonia and stridor may all be associated with dysfunction of vagus nerves (CN 10). Dysphagia due to pharyngeal muscle paresis or paralysis can be observed when the animal attempts to swallow food. Megaesophagus associated with paresis or paralysis of the esophageal muscles results in regurgitation shortly after eating. Dysphonia may be witnessed as the animal attempts to bark or meow or may be an historical complaint and is associated with dysfunction of the laryngeal muscles. Stridor is usually heard and is often associated with unilateral or bilateral paresis or paralysis of the laryngeal muscles. Bilateral laryngeal paralysis can result in severe dyspnea and cyanosis and emergency measures may have to be taken to establish a patent airway.

Trauma to the vagus nerves can cause these signs but the diagnosis is usually obvious from the history or physical examination. Diagnostic tests on serum to consider include a CK level for polymyositis, T4, free T4 and TSH for hypothyroidism and serum Ach antibodies for myasthenia gravis which can all cause one or more signs of vagal nerve dysfunction. On rare occasions lead intoxication can cause megaesophagus and laryngeal paralysis so blood lead levels may be indicated. Hypoadrenocorticism may occasionally have an associated megaesophagus so adrenal function tests may be considered. Thoracic radiographs usually show megaesophagus although occasionally fluoroscopy with contrast administration may be necessary. Evidence of aspiration pneumonia may be apparent on thoracic radiographs of animals with dysphagia. Reduced or absent mobility of the one or both of the laryngeal folds are observed with laryngeal ultrasonography and upon laryngoscopic exam.

The EMG examination may be used to detect diffuse and nerve involvement. Laryngeal paralysis associated with polyneuropathy has been described in Dalmatians, Rottweilers and other dogs. Treatment of the underlying polymyositis, hypothyroidism, hypoadrenocorticism, myasthenia gravis or polyneuropathy often improves the clinical signs. In laryngeal paresis mild sedation may control stridor but in some cases a temporary tracheostomy may be needed to maintain a patent airway. Laryngeal surgery is avoided as recovery may occur once the underlying problem is controlled and if the protective function of the larynx becomes compromised, aspiration pneumonia can be a serious complication.
Congenital megaesophagus occurs in pure and mixed breed dogs and cats including Miniature Schnauzers, Wirehaired Fox Terriers, Newfoundlands, Labrador Retrievers, Chinese Shar Peis, Irish Setters and Siamese cats. Idiopathic megaesophagus occurs in Germans Shepherds, Golden Retrievers, Irish Setters, Great Danes, and other dogs and cats between 5-12 years of age. There is no specific treatment for congenital or idiopathic megaesophagus. Supportive care consists of feeding food formed into small balls from an elevated platform and then holding the animal vertical for 5-10 minutes after meals to prevent regurgitation. In severe cases a gastrostomy tube may have be used for feeding. About 20-40% of dogs with congenital megaesophagus may improve with age but spontaneous recovery of idiopathic megaesophagus is rare.
Congenital laryngeal paralysis occurs in young Bouvier des Flandres, Siberian Huskies and other breeds of dogs. Idiopathic laryngeal paresis or paralysis may occur in adult Labrador Retrievers, Afgan hounds, Irish Setters and other breeds of dogs and cats. Treatment usually involves some surgical intervention to distract vocal folds such as unilateral thyroarytenoid lateralization or partial laryngectomy to open the airway. The most frequent complication of dysphagia, megaesophagus and post-surgical laryngeal paralysis is aspiration pneumonia, which can be fatal.

Tongue Paralysis or Atrophy
Unilateral tongue paralysis or atrophy from a hypoglossal nerve (CN 12) lesion with no other neurologic signs is relatively rare but may be associated with peripheral nerve trauma or neoplasia. With no known history of trauma, MR imaging of the caudal brainstem area should be considered to rule out a neoplasia such as neurofibroma, meningioma, and lymphosarcoma of the hypoglossal nerve as it exits the brainstem.

Cranial Polyneuropathies

Multiple cranial nerves may be dysfunctional in dogs with acute polyneuropathies, chronic polyneuropathies, meningoencephalitis or neoplasia affecting the brainstem and cranial polyneuropathies. In animals with cranial polyneuropathies, only muscles associated with cranial nerves are abnormal on the neurologic and EMG exam. No other underlying polymyopathy, hypothyroidism, myasthenia gravis or polyneuropathy is detected. CSF analysis and MR are normal and help to rule brain stem inflammation or multiple peripheral nerve neoplasias such as lymphosarcoma. Chronic immune-mediated or paraneoplastic cranial polyneuritis is suspected. Treatment with prednisone with or without azathioprine and gastrointestinal protectants as described above for masticatory myositis can be tried. In some cases there is no response to therapy and the prognosis is grave.

Dysautonomia
Dysautonomia is an idiopathic dysfunction of the autonomic nervous system of dogs and cats that causes dilated pupils which are unresponsive to light with normal vision, anisocoria, prolapsed third eyelids, reduced tear and saliva production, megaesophagus, bradycardia, constipation and urinary incontinence. Affected animals may also show anorexia, weight loss, weakness and tremors. Reported cases are primarily from the United Kingdom with sporadic cases reported in the United States. The diagnosis is primarily based on the typical clinical signs. Urinary catecholamines are reduced.
Treatment is symptomatic and supportive. Initially fluid administration and electrolyte replacement therapy may be necessary. Gastrostomy feeding may be needed to maintain nutrition. The bladder may have to be expressed every 8 hours and laxatives may be given to assist defecation.
Administration of parasympathomimetic drugs such as oral bethanechol hydrochloride (Urecholine) 5-25 mg every 8 hours in dogs and 2.5-5 mg every 8-12 hours in cats may relieve some of the symptoms. One or two drops of 0.5% physostigmine or 1% pilocarpine ophthalmic preparations in both eyes every 12 hours may have some systemic effect. Aspiration pneumonia secondary to megaesophagus and urinary tract infections require antibiotic therapy. The demeanor and appetite of cats may improve with prednisone 1-5 mg every other day. Affected animals may recover after several months but the nursing care is so intensive that many owners elect euthanasia. A diffuse degeneration of the autonomic ganglia of unknown cause is found on necropsy examination.

CENTRAL NERVOUS SYSTEM DISORDERS
Cranial nerve signs plus unilateral or bilateral conscious proprioceptive deficits, hemiparesis or quadriparesis suggests brainstem disease.