The Paradox of the Vestibular Patient

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OBJECTIVES OF THE PRESENTATION

- To review the anatomy of the vestibular system and the pathophysiology of the vestibular disease
- How to distinguish between peripheral and central vestibular disease
- To review differential diagnoses and diagnostic testing for both peripheral and central vestibular disease

KEY POINTS

Vestibular disease is a common condition in veterinary medicine. Any dysfunction in this system can lead to very distressing signs for the patient and the client. Therefore, distinguishing between central and peripheral disease is important to guide further diagnostics and prognosis.

OVERVIEW

The vestibular system is responsible for maintain balance and posture relative to the head and body, as well as coordinating ocular position in relation the position or motion of the head. Diseases affecting this system can lead to gait abnormalities (falling, rolling, ataxia), head tilt, and nystagmus.

<u>Anatomy</u>

The vestibular system is functionally divided into the peripheral and central vestibular system. The peripheral vestibular system is located within the inner ear while the central vestibular system is within the brainstem, cerebellum, and spinal cord.

A. Peripheral vestibular system
    a. Receptors within the membranous labyrinth of the petrous temporal bone (inner ear).
        i. Utricle and saccule detect gravity and linear acceleration
        ii. Semicircular canals detect rotation
    b. Input from the receptors enters the brain via the vestibular portion of the vestibulocochlear nerve (CN VIII)
        i. Synapse on one of four vestibular nuclei in the brainstem
        ii. Small number bypass and terminate in the flocculonodular lobe of the cerebellum
B. Central vestibular system
    a. Brainstem projections
        i. Nuclei of cranial nerves III, IV, and VI via the medial longitudinal fasciculus (MLF) in the brainstem to coordinate eye movement
        ii. Vomiting center within reticular formation
    b. Spinal cord projections

        i. Vestibulospinal tract descends from vestibular nuclei to all segments of the spinal cord
            1. Overall effect is ipsilateral increase in antigravity muscle tone and contralateral inhibition of tone and stretch reflexes
    c. Cerebellar projections
        i. Bypass vestibular nuclei and project to flocculonodular lobe of cerebellum

Clinical signs

A. A head tilt is the most common sign of vestibular disease.
    a. Due to loss of antigravity muscles on one side of the neck and is on the ipsilateral side of the lesion, except in paradoxical vestibular disease (see below)
    b. Important to differentiation between a head tilt and head turn. A head turn is indicative of a forebrain lesion.
B. Nystagmus
    a. Defined as involuntary, rhythmic movement of the eyeballs. May be physiologic or pathologic
        i. Physiologic nystagmus occurs in normal animals and is induced by rotating the head from side to side
            1. May be depressed in unilateral or absent in bilateral vestibular disease
        ii. Pathologic nystagmus can be spontaneous (present when head at rest) or positional (becomes present or alters character when patient is placed in dorsal recumbency)
    b. Jerk nystagmus is characterized by a slow phase in the opposite direction as the head rotation and fast compensatory phase
    c. Described based on direction of fast phase, axis of movement (horizontal, rotary, vertical), and relationship of eye movement (conjugate vs disconjugate)
C. Ataxia
    a. Hallmark is asymmetry! Characterized by swaying of the head and trunk, wide-based stance, leaning, falling, rolling to side of lesion
    b. May see circling (usually tight) towards lesion
D. Strabismus
    a. Ventral or ventrolateral deviation of the globe that is ipsilateral to the lesion

Lesion Localization

A. Peripheral vestibular disease
    a. No effect on strength, proprioception or mentation
    b. Head tilt, circling, or falling toward lesion
    c. Spontaneous or positional nystagmus with fast phase away from lesion
        i. Horizontal or rotary direction with no change in direction with head position
    d. Strabismus on same side as lesion

    e. +/- facial nerve paralysis or Horner's syndrome
B. Bilateral peripheral vestibular disease
    a. Absence of head tilt and pathologic nystagmus
    b. Absent physiologic nystagmus
    c. Wide lateral head excursions from side to side
    d. Crouched posture, reluctant to walk, may fall to both sides
C. Central vestibular disease
    a. Ipsilateral proprioceptive deficits and weakness
    b. Head tilt, circling, or falling toward lesion
    c. Nystagmus may be horizontal, rotary, or vertical. It may also change direction
    d. Altered level of consciousness due to involvement of the reticular activating system (RAS)
    e. Other cranial nerve deficits (CN's V, VII, IX, X, XI, XII)
D. Paradoxical vestibular disease – lesion in flocculonodular lobe of cerebellum or caudal cerebellar peduncles
    a. Form of central vestibular disease with head tilt and circling opposite the lesion
    b. Will also see cerebellar signs (ataxia, head tremor, truncal sway)
    c. Signs are due to contralateral side of lesion having less vestibular tone due to disinhibition of ipsilateral vestibular nuclei
    d. ALWAYS indicates central process

Table 1. Clinical features in peripheral and central vestibular disease

Clinical Sign	**Peripheral**	**Central**
Head tilt	Toward lesion	Toward lesion (except paradoxical)
Nystagmus	No change in direction Horizontal or rotary	May change direction Horizontal, rotary, or vertical
Postural reaction deficits	No	Yes, ipsilateral to lesion
Other cranial nerve deficits	Ipsilateral CN VII	CN V-XII, ipsilateral
Horner's syndrome	+/-	No
Altered Conciousness	No	Possibly

<u>Differential Diagnoses</u>

Differential diagnoses for vestibular are highly variable depending upon if the process is central or peripheral in origin. Using the DAMNNIIT-V system is recommended when determine a list of differential diagnoses for both peripheral and central vestibular disesase.

Table 2. Differential diagnoses for peripheral and central vestibular disease

Disease Mechanism	**Peripheral**	**Central**
Degenerative		Lysosomal storage diseas Neurodegenerative diseases
Anomalous	Congenital vestibular disease	Quadrigeminal arachnoid cyst Epidermoid/dermoid cyst Chiari-like malformation

Metabolic	Hypothyroidism	Hypothyroidism (+/- infarction)
Neoplastic	Middle/inner ear tumor	Primary or metastatic brian tumor
Nutritional		Thiamine deficiency
Idiopathic	Idiopathic vestibular disease	
Infectious/inflammatory	Otitis media/interna Nasopharyngeal polyps	Viral – CDV, FIP Bacterial – Abcess, RMSF, ehrlichiosis, bartonellosis Protozoal – Toxoplasmosis, Neosporosis Mycotic – Cryptococcus, blastomycosis Noninfectious – meningoencephalitis of unknown etiology
Trauma	Head trauma	Head trauma
Toxin	Ototoxic drugs – aminoglycosides, topical chlorhexidine, loop diuretics	Metronidazole
Vascular		Infarct – ischemic or hemorrhagic

<u>Diagnostic Testing</u>

The choice of diagnostic testing is largely determined on the suspicion of where the lesion is located (peripheral vs central) based on the neurologic examination. If in doubt, evaluate the patient for both.

A. Peripheral vestibular disease
    a. Otoscopic examination +/- radiographs of the middle/inner ear
        i. Otitis media/interna or possible lytic bone lesion (neoplasm)
        ii. Radiographs may be normal with otitis media/interna
    b. Pharyngeal exam
    c. Minimum database
        i. Complete blood count, serum biochemistry panel, thyroid panel
    d. MRI (or CT if suspect otitis media/interna)
    e. Ear cytology +/- myringotomy and culture
    f. Ventral bulla osteotomy (almost always in cats)
    g. Electrodiagnostics if concerned about cranial nerve neuropathy
B. Central vestibular disease
    a. Advanced imaging (CT or MRI, preferred)
    b. CSF analysis
    c. Serum and CSF titers (serology or PCR) for infectious organisms
        i. *Neospora caninum*, *Toxoplasm gondii*, CDV, *Coronavirus* (FIP), fungal serology
    d. +/- biopsy

e. Minimum database as above plus urinalysis, thoracic radiographs, abdominal ultrasound, and blood pressure
f. Fundic exam
g. Clotting profile
h. Urinary organic acid excretion panel for thiamine deficiency