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Paws, Claws, and Balance Laws: Animal Vestibular Disorders Explained, presented in partnership with the American Academy of Audiology

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Disclosures

- **Presenter Disclosure:** Financial: Patricia Gaffney was paid an honorarium for this presentation. She is faculty at Nova Southeastern University and Adjunct Faculty at University of South Dakota. Non-financial: Patricia Gaffney is a former president of the American Academy of Audiology.
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- Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs.
- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

Learning Outcomes

After this course, participants will be able to:

- Compare and contrast human and canine/feline anatomy.
- Identify 4 disorders associated with dizziness/vestibular dysfunction in animals.
- List 3 findings on animal assessments consistent with vestibular abnormalities.



Outline

- Comparative anatomy and epidemiology
- Disorders causing dizziness and vestibular dysfunction in animals
- Assessment for vestibular dysfunction
- Case studies
- Summary and questions

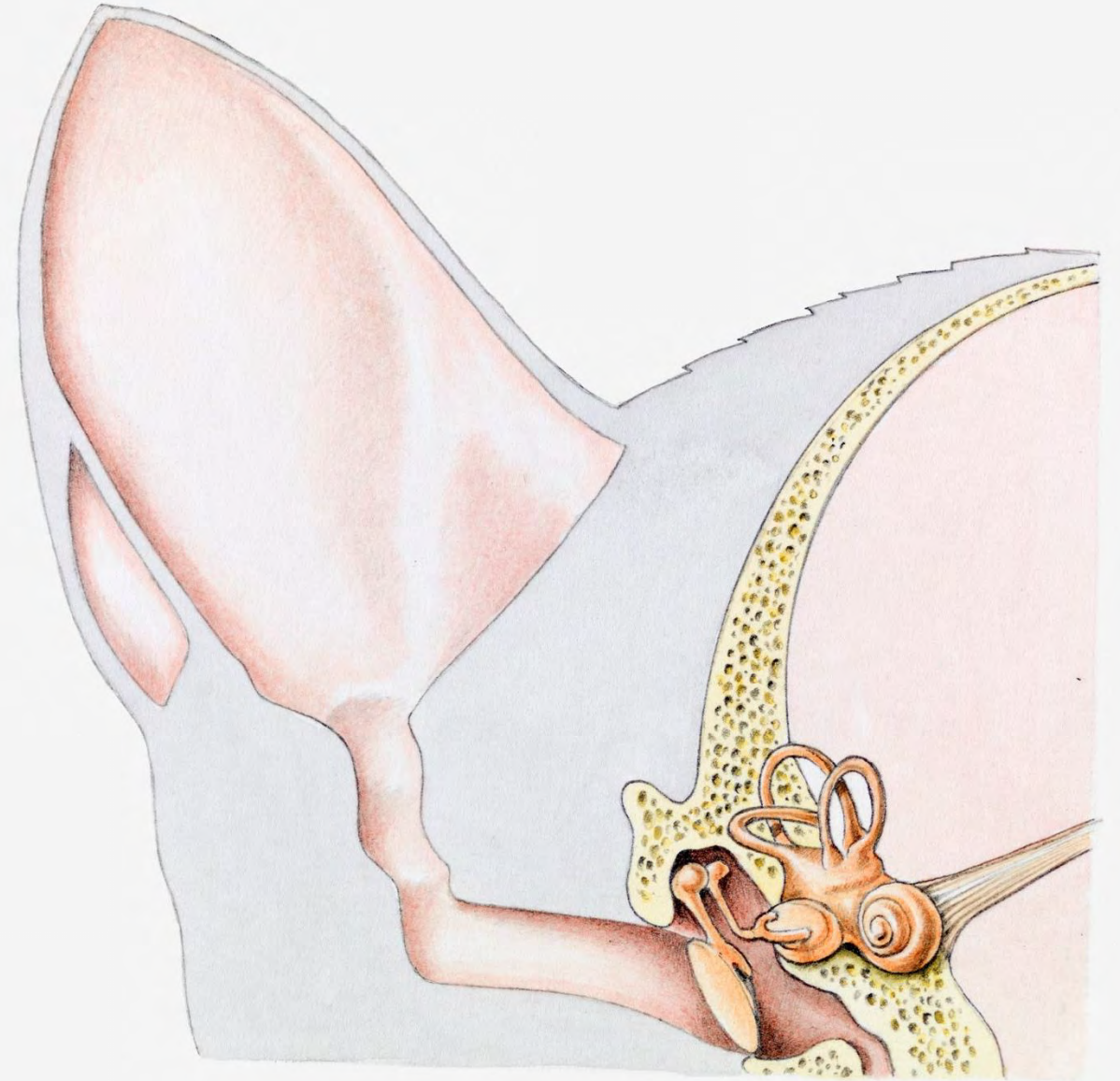
Comparative anatomy and epidemiology

Animal Vestibular system

- Overall vestibular structure between mammals and is similar to humans and other mammals
 - Semicircular canals and otoliths
- Size varies based on species
- Most inner ear variations are on the cochlear side
- There are variations in the number of SCCs in different types of animals
 - Jawed vertebrates have 3 SCC
 - Including mammals
 - Jawless vertebrates (ex. Lampreys) have 2 SCC
 - Hagfish have 1 SCC



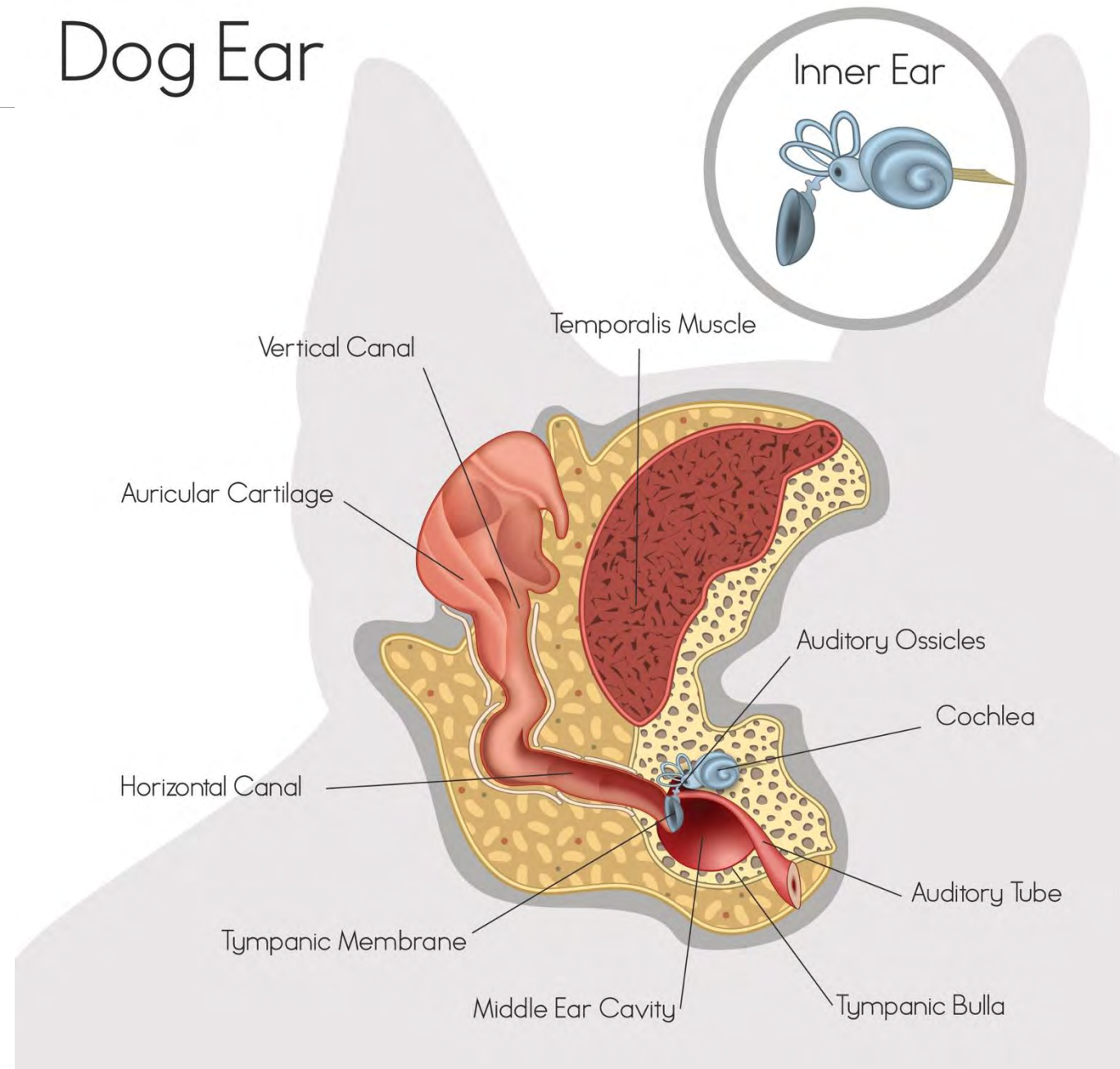
Animal Vestibular System





Dog Ear

Animal Vestibular System





Animal Vestibular System

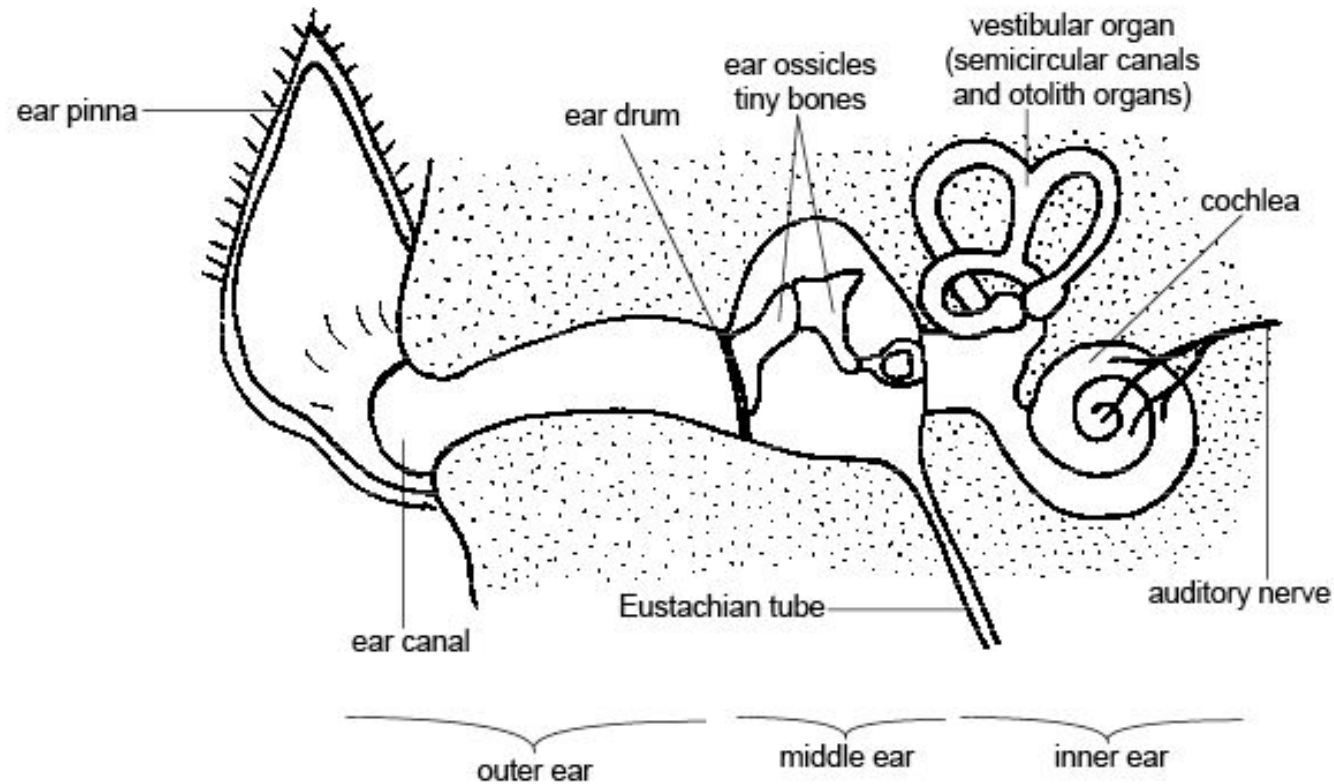
- Canine





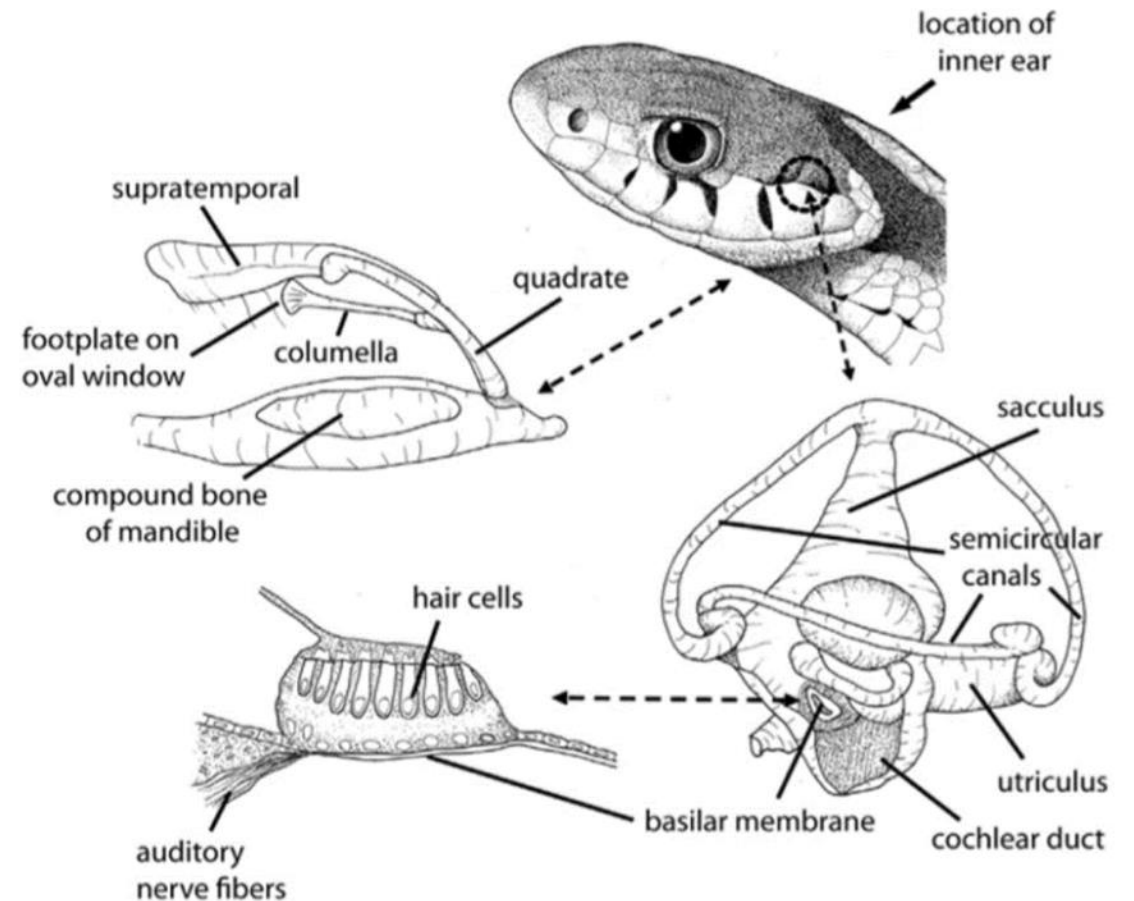
Animal Vestibular System

- Equine



Animal Vestibular System

- Snake





SCC Curvature

- Ekdale (2016)
 - The arc of the anterior semicircular canal tends to be more elliptical in marine carnivorans such as pinnipeds than in terrestrial species such as canids
 - The AC-SCC tends to have the greatest radius of curvature in mammals-meaning they are more sensitive to pitch rotations
 - But in some marine animals (dolphins, sea lions, manatees), the HC-SCC has the greatest arc

SCC Size x Body Mass x Agility

- Spoor et al (2007)
 - 210 mammals/ 91 primates
 - Although not fully investigated, there are trends to suggest that based on neurophysiology there is a relationship between the radius of the arc and the sensitivity of the canal
 - Faster/more agile animals have large canals relative to body size
 - Large SCCs are more sensitive to rotations in space than smaller canals
 - Slower moving animals tend to have smaller canals than faster moving animals
 - Examples:
 - Galagos and leaping tarsiers have larger canals for their body size
 - Sloth lemurs and koalas have small canals for body size



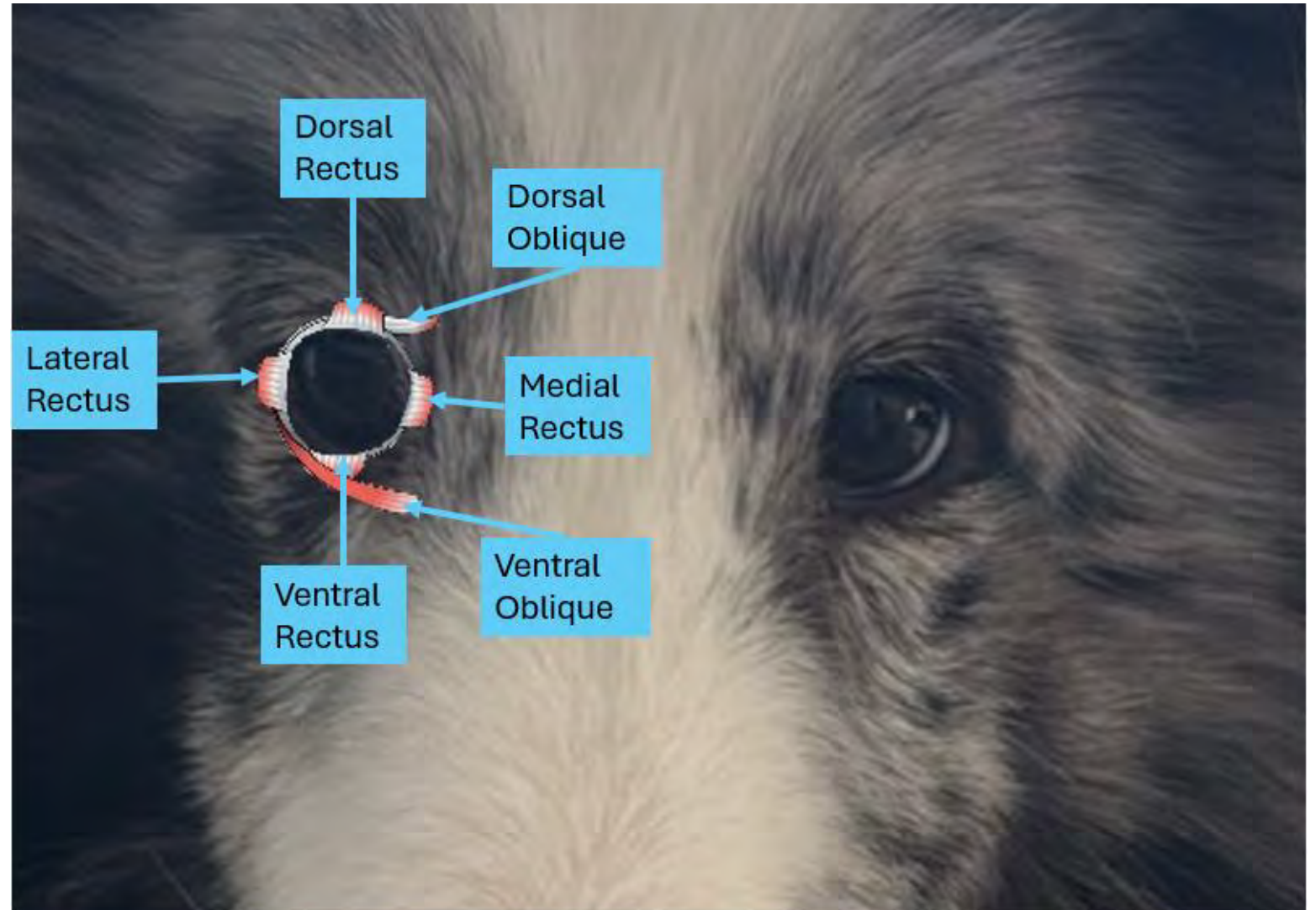
The Exception in Sea Mammals

- Spoor et al (2002)
 - Early cetaceans evolved from land to obligate aquatic behavior
 - Whales are unique in that they have a SCC arc size 3 times smaller for their body mass compared to other mammals
 - The SCC of blue whales are smaller than humans when accounting for size
 - The small SCC size of cetaceans has been interpreted as a vestigial condition, in which receptors are lost because of limited neck and eye motility



Oculomotor

- Same musculature around orbit
- Slightly different names
- Same cranial nerve innervation





Animal Vestibular Physiology

- The ear physiology of mammals is very similar to humans from the standpoint of endolymph flow, cupular deflection, and otolith stimulation
- The neural pathway for the VOR is also similar to humans
- Particularly the VOR and VSR



Breeding and Impact on Vestibular System

- Breeding changes over time have led to alterations in structural form of many dog breeds.
- In some breeds this has been detrimental to health particularly in brachycephalic breeds
- Smith & Laitman (2020) evaluated inner ears various dog breeds
 - They found that highly derived breeds, had high risk for changes to the labyrinth structure which can have an impact on vestibular function



Comparative Anatomy
and Epidemiology

Mütter Museum

- Josef Hyrtl collection





Epidemiology – Canine

- Radulescu, et al (2020)
 - 905,544 dogs reviewed from 886 veterinary clinics in the UK for vestibular disease
 - 2600 dogs identified as potential candidates- with 759 cases being confirmed
 - Prevalence of 8 per 10,000 dogs
 - Prevalence of dogs over 9 yrs old 36 per 10,000 dogs –mean age of onset 12.68 yrs
 - Most common symptoms:
 - Head tilt (69.82%)
 - Nystagmus 67.98%
 - Ataxia 64.42%
 - Vomiting 25.7%

Epidemiology Canine – Radulescu et al (2020)

- Nystagmus
 - 58% had horizontal nystagmus (23% -leftbeating and 22% rightbeating)
 - 7% upbeating
 - 5% torsional
 - 1 dog had disconjugate nystagmus
- Breeds
 - French Bulldogs and Bulldogs had the highest odds of a vestibular diagnosis
 - Overall brachycephalic breeds have a higher incidence
 - King Charles Spaniels and other spaniel breeds also had increase odds ratio
 - West Highland White, Jack Russel and Yorkshire Terriers have decreased odds of vestibular disease



Epidemiology Canine – Radulescu et al (2020)

Age	Cases	Prevalence (per 10,000)
0-3 years	13 (out of 329,266)	0
3-9 years	101 (out of 385,353)	3
9-12 years	110 (out of 108,475)	10
12+ years	526 (out of 692,279)	8



Epidemiology Canine – Radulescu et al (2020)

- Prevalence by breed (greatest to least) - prevalence based on per 10,000 dogs
 - King Charles Spaniel (32)
 - Springer Spaniel (31)
 - Golden Retriever (28)
 - Cavalier King Charles Spaniel and Border Collier (23)
 - Boxer (16)
 - Bulldog (15)
 - Miniature Schnauzer (13)
 - Labrador Retriever (12)
 - Beagle (10)
 - West Highland White Terrier, German Shepherd, Cocker Spaniel and Border Terrier (9)
 - Crossbreed (8)
 - French Bulldog, Staffordshire Bull Terrier, Jack Russeel Terrier (7)
 - Yorkshire Terrier, Shih-Tzu, and other purebreds (4)

Disorders Causing Dizziness and Vestibular Dysfunction in Animals

Congenital Peripheral Vestibular Syndromes

- There are certain breeds that have known congenital peripheral vestibular syndromes

Canine

- German Shepherd
- Doberman Pinscher
- Akita
- English Cocker Spaniel
- Beagle
- Smooth Fox Terrier

Feline

- Siamese
- Burmese
- Tonkinese

For Example...

- Doberman puppies show a degeneration of cochlear neuroepithelium and missing or abnormal otoliths in the macula- this is suspected to be an inherited autosomal recessive disorder
- Some also have hearing loss like Dobermans, Akitas, and Siamese cats

Sumatran Tigers – Congenital Vestibular Disease

- Wheelhouse et al (2015)
 - 93 Sumatran tigers from 14 zoos in Australia and New Zealand- records reviewed
 - Retrospective study
 - 14 tigers were positive for congenital vestibular disease
 - Onset was between 1-60 days (mean 25 days)
 - All had ataxia, head tilt, and disorientation. 78% had strabismus.
 - 6 had VOR testing assessed and noted strabismus was prominent in positionals
 - Believe it to be a combination of genetic and environmental effects

Infection – Otitis Media/Interna

- Infection causing dizziness and vestibular symptoms is common.
- Infections of the middle/inner ear are a known suspect for sudden onset of vestibular symptoms- particularly in the tympanic bulla
- This can be seen on imaging within the deep cavity of the tympanic bulla

Infection – Otitis Media/Interna

- Can affect both cats and dogs (Lundgren, 2026)
 - 16% of dogs that have acute (rapid onset) otitis externa
 - 52% of dogs that have chronic (long-term) otitis externa
 - 63% of cats that had otitis media/interna did not have a previous history of ear infection.
- This can impact other animals as well – examples of ruminants with these infections causing dead tilt towards the affected side and loss of balance

Listeriosis – Case Study

- Ewe is bright alert and responsive
- It is the only affected individual in the flock
- Reduced feed intake
- General clinical examination was normal
 - Right sided head tilt
 - Left sided nystagmus
 - Muscle fasciculations (twitching) on right side of muzzle
 - Stumbling to the right
- Dx and TX: The history and clinical signs in this ewe were highly suggestive of listeriosis and so treatment was initiated with a 5 day course of intramuscular procaine penicillin and a one of injection of dexamethasone. The ewe improved with treatment with a resolution of most of the neurological signs and an improvement in the head position. The ewe also returned to normal appetite.

Labyrinthitis

- Infection of the vestibulocochlear labyrinth caused by bacteria, viruses, spirochetes, or fungi
- Suspect that it is 50% of peripheral vestibular disease in canines and is mostly related to otitis media and interna (OMI)
- Affects hearing and vestibular, but most owners note the loss of balance
- In humans there is a large portion who lose hearing related to autoimmune inner ear disorders, but there is no similar reports in veterinary literature.
- Since most labyrinthitis cases in animals is related to infection, treatment is aggressive surgical debridement to make sure it does not invade into the brain

Canine Ehrlichiosis

- Tick-borne infection
 - Primarily from brown dog ticks and Lone Star ticks
- Most common bacteria responsible is *Ehrlichia canis*, though *E. ewingii*
- In chronic cases, neurological signs such as seizures and vestibular signs—possibly related to spontaneous bleeding or meningitis—can be observed
- Treatment is typically antibiotics such as doxycycline

Canine Ehrlichiosis

- Benito et al (2025) had a case report of 4-year-old, shepherd crossbreed, female neutered was assessed for a 2-month history of intermittent vestibular episodes, lasting from seconds to over 2 min with spontaneous resolution.
 - MRI testing revealed vasculitis (inflammation of blood vessel walls) particularly brainstem and cerebellum
 - Serology testing can also be ordered. Other symptoms include fever and neurologic symptoms such as strabismus

Ototoxicity

- Most frequent in vet med:
 - Aminoglycoside antibiotics- particularly gentamicin
 - Polypeptides (antibiotic)
 - Chloramphenicol (antibiotic)
 - Erythromycin (antibiotic)
 - (Oxy)tetracycline (antibiotic)
- Also some disinfectants/antiseptics:
 - Clioquinol, chlorhexidine, cetrimide, iodine, povidone-iodine, and ethanol

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Ototoxicity

- Effects are dose related
- For hearing- the hearing loss may go unnoticed for some time
- Clinic signs:
 - Can happen within 10 mins
 - Horizontal nystagmus with fast phase to the affected side
 - Strabismus
 - Ataxia
 - Head tilt
 - Circling
 - Nausea
 - Refusal of food

Ototoxicity

- Central compensation is generally within 3 days
 - Nystagmus decreases
 - Gradual attempts to stand
 - More effort in eat and drink
 - Head tilt remains
- Within 3 weeks
 - Gradual improvement, but may still struggle with jumping and going down stairs
- By 3 months – compensation is complete
 - Head tilt may be permanent

Inner Ear Trauma

- Types of trauma- blunt trauma to the head
 - Temporal bone fracture
 - Concussion
 - No known reports of barotrauma from veterinary literature
- No specific treatment for the animals

Idiopathic Peripheral Vestibular Syndrome

- AKA *Old Dog Vestibular Syndrome*
- Common
- Canine Vestibular disease
 - Mean age of onset is 12.5 yrs and rare seen in dogs under 5 yrs of age
- Sudden onset
- Head tilt, nystagmus, circling, loss of balance/ataxia, nausea/ vomiting
- Often reported that it appears overnight
- Gradual improvement over days to weeks

Idiopathic Peripheral Vestibular Syndrome

- Diagnosis of Exclusion
- Pathophysiology possibilities
 - Endolymphatic abnormalities
 - Micro-intoxication or ischemia
 - Viral or immune mediated inflammation
 - Degenerative changes

Idiopathic Peripheral Vestibular Syndrome

- Harrison et al (2020)
- Vestibular syndrome animals tended to be older while otitis media/interna dogs were younger and lower body weight
- Infarcts were also associated with older age
- *“Although this study aimed to identify easy to recognise clinical characteristics associated with the most common causes of canine vestibular syndrome, this study failed to identify discrete clinical features that would be predictive for one of the most commonly identified causes of vestibular syndrome and meningoencephalitis of unknown origin” (pg 9)*

Feline Idiopathic Peripheral Vestibular Disease

- Can occur at any age
- Higher incidence in outdoor cats during summer and autumn months in the NE and Mid-Atlantic USA regions
- Typically, bilateral
- Differential diagnosis
 - Do not have concurrent facial nerve paralysis or postganglionic Horner syndrome (affects 3rd eyelid and ptosis)
 - Exclusionary diagnosis
 - They can have head tilt, rolling, falling, and vomiting
 - Diagnostic testing is normal

Feline Idiopathic Peripheral Vestibular Disease

- Won and Yoon (2020)
 - Using MRI they determined that there is a utricular asymmetry
 - Those with vestibular syndrome had larger utricular diameter

Idiopathic Peripheral Vestibular Disease – Rabbits

- Senior rabbits can have a vestibular event similar to senior canines
- In older rabbits it is often caused by *Encephalitozoon cuniculi* infection, chronic otitis interna, or brain lesion
- Most common symptom is head tilt
 - May also exhibit rolling and circling

Cerebellar Hypoplasia

- Prikryl, et al (2020) reported on 3 dog
 - Golden retriever- 2-3 yrs old
 - Head tilt, mild cerebellar ataxia, vertical nystagmus, mild pelvic limb incoordination, truncal sway
 - 22 months later- the dog was stable with transient vestibular episodes when playing
 - Pug- 2 months old
 - Vestibular episodes, ataxia, increased with playing and eating, head tilt, drifting, wide base of support
 - 4 months later- learned to compensate episodes sometimes continue to occur with playing
 - Boston Terrier- 7 month old
 - Episodes after sniffing and eating, head tilt, vestibular ataxia, wide base of support
 - 7 months later- episodes remain when playing or sniffing

Stroke

- Wessmann et al (2009)
 - Rare in dogs
 - Need imaging to confirm stroke and determine site of lesion
 - If no other underlying disease the prognosis is good
- Symptoms:
 - A head tilt
 - Difficulty walking
 - Loss of housetraining
 - Change in personality
 - Less awareness of surroundings
 - Abnormal eye movement or positioning
 - Falling/listing to one side
 - Blindness
 - Seizures

Neoplasms

- Neoplasms can also occur- MRI is key to diagnosing
- Central patterns of findings
- Jahns and McElroy (2022)
 - 21 cases of cattle
 - Symptoms: altered mental state/behavioral changes, cerebellar incoordination, and vestibular syndrome

Toxicity – Grapes/Raisins

- Schweighauser, et al (2020)
 - Dogs that eat grapes/raisins it can cause acute kidney injury (AKI)
 - Retrospective study- 89 dogs
 - Some dogs exhibited symptoms that could mimic vestibular – head tilt, drifting, ataxia
 - Neurologic symptoms are localized to thalamus and cerebellum

Pituitary Apoplexy

- Neurologic signs due to hemorrhage or infarct within a normal pituitary gland
- Galli, et al (2022)
 - Retrospective study- 19 dogs were evaluated
 - 7 were classified as having vestibular signs
 - Mean age was 10.7 yrs old
 - Typically diagnosed between neurologic signs and imaging
 - Symptoms could look like vestibular
 - Loss of balance, nystagmus, circling
 - Differential signs- seizures and aggressive behavior- need imaging

Summary – Dogs and Cats

Adapted from Kent et al (2010)

Disease Mechanism	Specific Disease	Diagnosis	Prognosis
Anomalous	Congenital vestibular disease	Based on age and breed Exclusion of other causes	Fair- some compensatory recovery. May have hearing loss
Neoplasms	Carcinomas (various)	Otoscopy, imaging, and histopathology	Poor
Inflammatory/ Infection	OMI, Labyrinthitis	Otoscopy, ear swab, myringotomy, and imaging	Good
Idiopathic	Idiopathic vestibular syndrome	History- onset without progression Exclusion of other causes	Good
Toxic	Aminoglycosides, furosemide, chlorhexidine, 10% fipronil solution	Onset with exposure to the toxin	Fair- some compensatory recovery, likely permanent hearing loss
Traumatic	Iatrogenic, fracture	Onset with traumatic episode	Fair- some compensatory recovery, likely permanent hearing loss

Differential Diagnosis

- Just like human differentials need to piece all the components together for a differential in animals
- More difficult due to lack ability to communicate with animals
 - Rely on owner information
- Also cost of assessments

Assessment

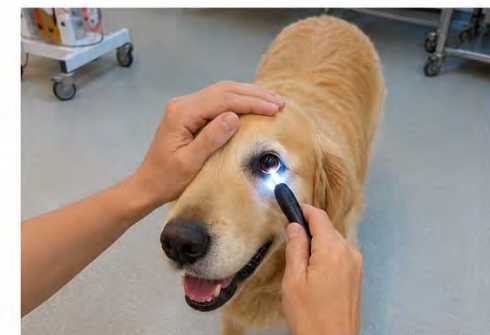
- History
 - Onset of dizziness/imbalance
 - Symptoms
- Otoscopy
- Neurologic Exam
 - Mentation
 - Engaging with the environment and commands
 - Gait and Posture
 - Look for weakness, ataxia, incoordination
 - Cranial Nerves
 - Facial symmetry, blink reflex, menace response, move head- VOR nystamgus, pupil reflex
 - Postural Reactions
 - Lift limbs and move the abnormal to look at reaction
 - Spinal Cord Reflexes
 - Patella reflexes, truncal reflexes, spinal muscle symmetry, range of motion at the cervical spine
 - Nociception
 - Pinch tail or toes, withdraw reflex from toes

Assessment- Pen Cover Test

- Chan et al (2025) to differentiate peripheral from central by removing fixation via the penlight
 - “it involves covering one eye and shining a bright light into the other tested eye, effectively dazzling the animal and preventing the animal from spontaneously fixating” (p 2)
- Increases in beat frequency and slow phase velocity during the modified penlight-cover test were more common in dogs and cats with peripheral vestibular lesions than in those with central lesions diagnosed by MRI



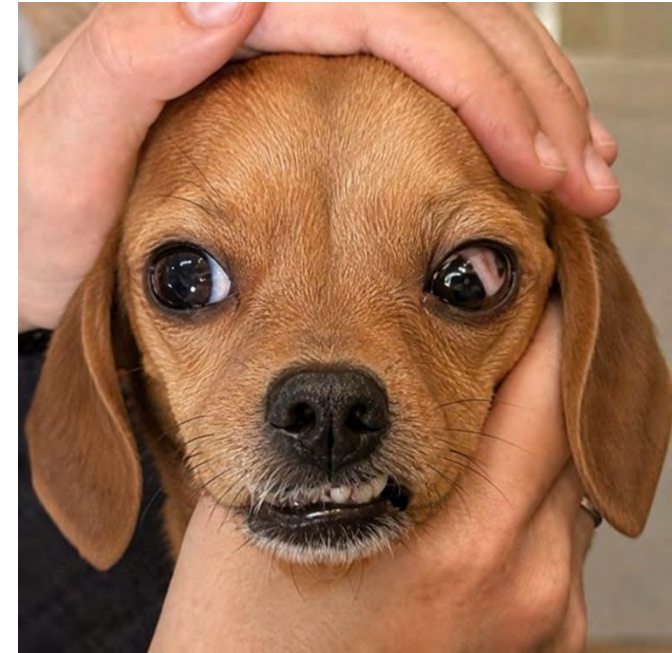
The patient is first examined before visual fixation is removed.



The patient is then examined after visual fixation is removed.

Vestibular Strabismus

- Elevating the head up causes the eye on the side of the lesion to deviate ventrally
- May be only sign in mild cases



Horner's Syndrome

- Dysfunction of the oculosympathetic pathway characterized by miosis, enophthalmos (posterior displacement of the eye in the socket), protrusion of the third eyelid, and ptosis
- 3 neuron pathway:
 - Central/first order neuron arises from the hypothalamus and extends down the spinal cord
 - Preganglionic/second order neuron arises from the first 3 thoracic spinal cord segments and travels through the thorax and cervical region until it synapses at the cranial cervical ganglion
 - Postganglionic/third order neuron travels from this ganglion to the orbit some fibers going through the tympanic bulla
- Can happen at any age and breed of cat and dog
 - Although some dogs may be more prone: Golden Retrievers in particular (Abrams 2003)

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Lab Work and imaging

- General lab work
- Urinalysis
- CT or MRI- imaging often used to confirm central abnormality
- Possible CSF spinal tap

Assessments for Idiopathic Vestibular Syndrome

- Mertens, Schenk, & Volk (2023)
 - Surveyed vets across North America, UK, and Europe
 - Top assessments for dogs and cats
 - Neurologic Exam
 - MRI
 - Serum Biochemistry
 - Complete Blood Count
 - CSF
 - Blood Pressure
 - Otoscopy

Peripheral vs Central

Adapted from Rossmeisl (2010)

Clinical Sign	Peripheral	Central
Head tilt	Ipsilesional	Either side
Nystagmus	Horizontal, beats contralesional, direction fixed	Direction fixed or changing Horizontal, rotary or vertical
Postural reactions	Normal	Defects ipsilesional
Conscious Proprioception (know where their paws are in space)	Normal	Defects ipsilesional
Cranial nerve deficits	Ipsilateral CN VII	Ipsilateral CN V-XII
Horner Syndrome	Postganglionic	Preganglionic (rare)
Consciousness	Normal, may be disoriented in acute phase	Normal to comatose

Treatment Options

- Symptom management
 - Nausea/vomiting
 - Making sure their environment is safe
- Antibiotics for infection
- Possibly steroids
- Possible surgery for non-vestibular issues
- Other medications for non-vestibular issues (ex. Parasites, stroke, etc.)

Treatment

- Vestibulosedative drugs are not routinely recommended as it will affect compensation and habituation
- Henze, et al (2022) Administration of ondansetron IV is beneficial for dogs with nausea secondary to acute vestibular syndrome. Ondansetron substantially and rapidly decreased clinical signs of nausea behavior and stopped emesis
- If there is significant vomiting can give:
 - H1 histaminergic receptor antagonists
 - M1 cholinergic receptor antagonists
 - Vestibulosedative drugs

Treatment

- Mertens, Schenk, & Volk (2023)
- Top treatment from vets for cats and dogs:
 - Maropitant citrate (Cerenia)
 - Physiotherapy
 - IV infusion
 - Propentofylline (only by EU vets) – neuroprotective agent to improve cognitive function

Prognosis

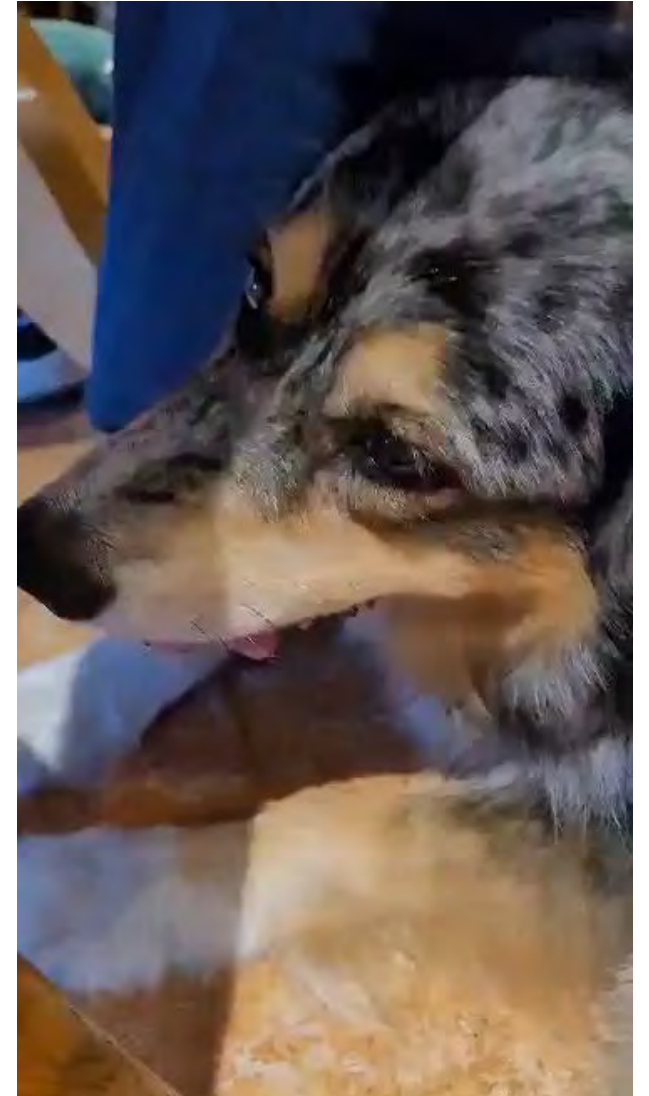
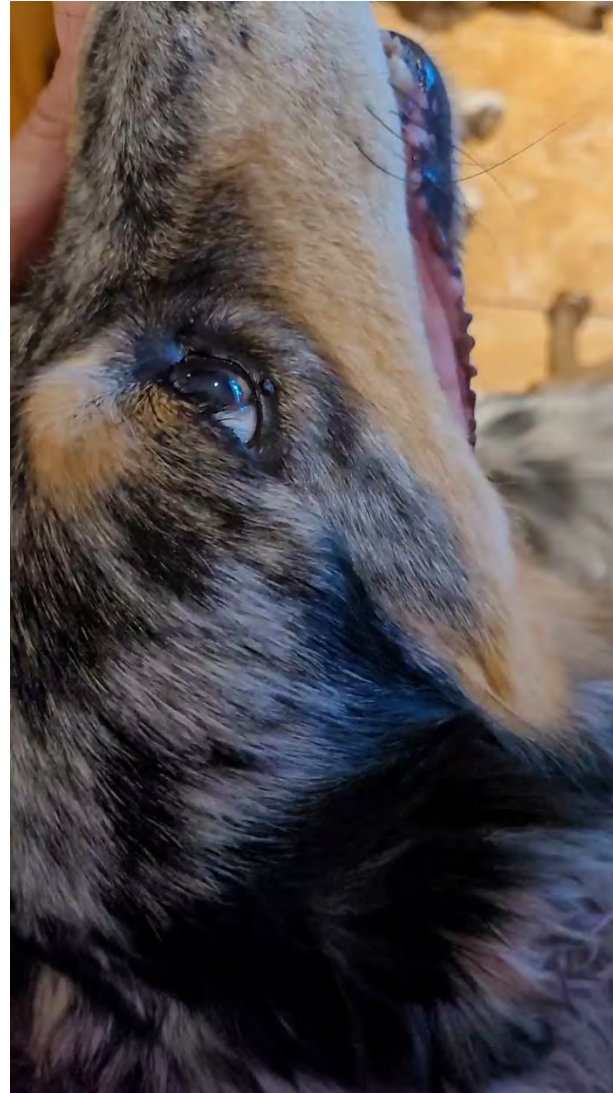
- If it is just vestibular- likely will recover in a short period of time
- If an infection is managed- likely to recover
- If there is an underlying infarct or tumor- the location and severity will impact likelihood of recovery

Cases

All cases have given permission to share

Case Study – Emma

- 13 yr old Australian Shepard
- Sudden onset 11pm
 - Reported as unbalanced, shaking her head and would splay out with all 4 feet
- Next morning she was better, but still unsteady
 - No nystagmus at that time, slight head tilt, no circling
- The next morning there was a head tilt, nystagmus and circling
 - Denied vomiting and ataxia
- Videos from that day
- She gave Emma meclizine for a few days



✓ Case Study – Emma



Throughout the day

✓ Case Study – Emma

4 days after onset

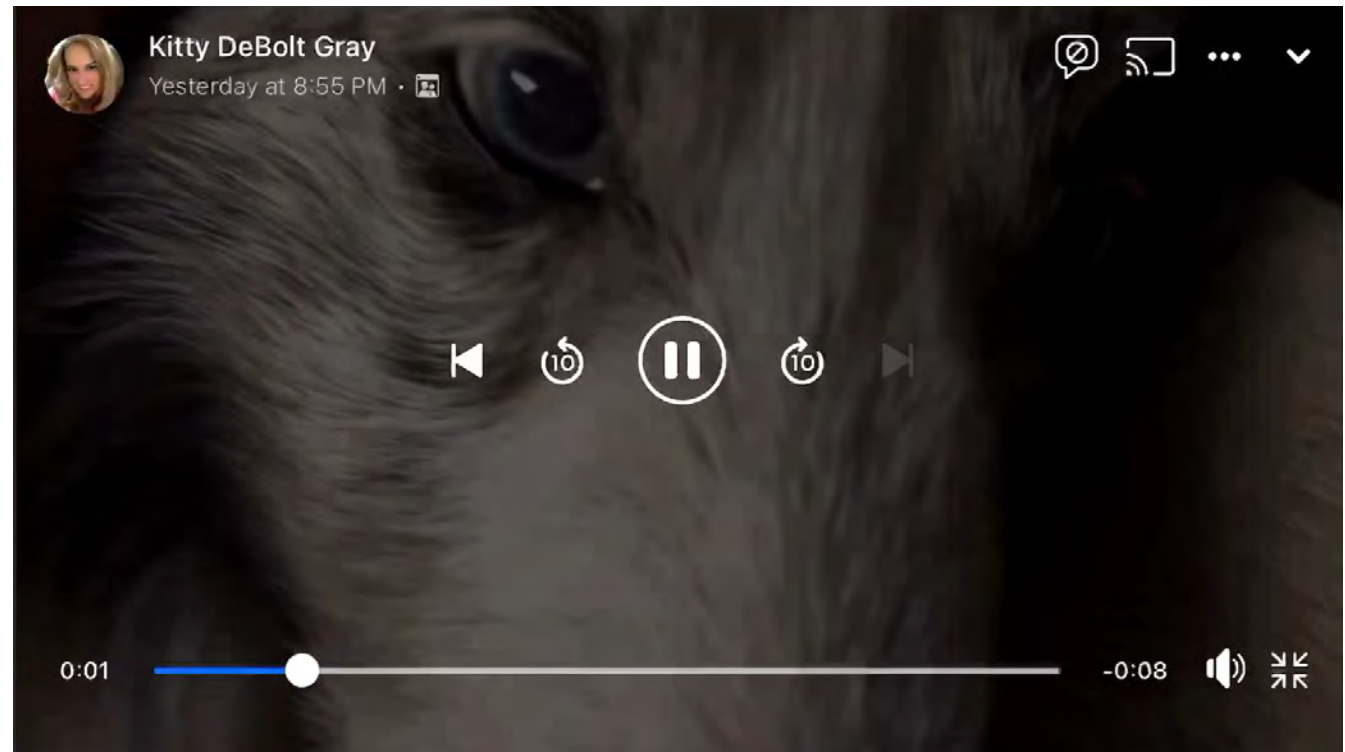


3 months later



Shadow – 12-Year-Old Sheltie

- Had nystagmus for 1 hour+
- Taken to the vet-diagnosed with vestibular disorder
- Gave the dog rimadyl
- He was back to normal after a few days





Hershey – 14-Year-Old

- Had a seizure
- Next day nystagmus started
 - Couldn't walk, left beat nystagmus, and head tilt
- Update- nystagmus, head tilt, and walking issues gone after a week
- Not confirmed vestibular

Syddne

- 13-year-old miniature schnauzer
- Vet:
 - Recurrent vestibular signs
 - MRI completed – negative
 - Dx: idiopathic vestibular disease



✓ Case Study – Syddne



Veterinary Radiation Oncology of the
Chesapeake
808 Bestgate Rd
Annapolis, MD, 21401
Ph 443-458-5657
Fax 443-782-0708
Email info@vroccvrc.com

Client Details

Name

Address

Phone(s)

December 19, 2023

Dear Patricia,

Syddne received a radiation therapy treatment today for Sarcoma, Soft tissue sarcoma. Below is a summary of her visit with us today.

History:

Syddne is stable at home. Her vestibular signs are still present though they are improving. She is still eating and drinking well with no vomiting or diarrhea. Syddne continues to receive levothyroxine and prednisone daily.

Patient Details

Name

Syddne

Species

Canine (Dog)

Breed

Minature Schnauzer

Age

13 years 1 month 19 days

Sex

Female Spayed



Vet report (5 days after initial visit):

Left sided-head tilt (improved)

Unable to turn right

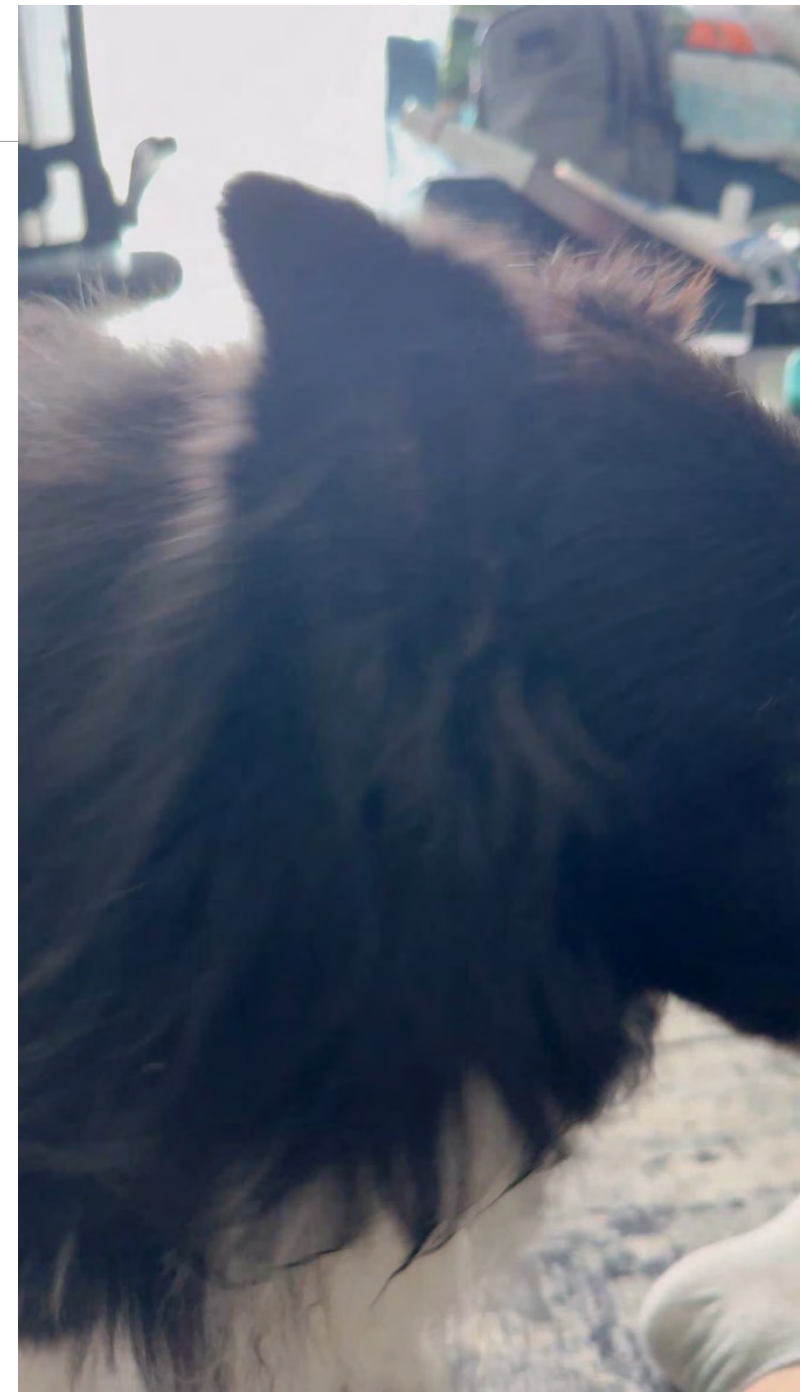
Circling left

No nystagmus

✓ Case Study – Islay

Islay

- 13 yo sheltie
- 8/31/25
- Woke up noticed head was bobbing, then saw the left beating nystagmus
- Unstable gait
- Head tilt



Islay

- She walked herself to her crate
- I kept her in there
- She was drooling (nausea)
- Given meclizine 12.5 mg
- Hung out in the crate for a bit until the drooling had stopped



✓ Case Study – Islay

Islay

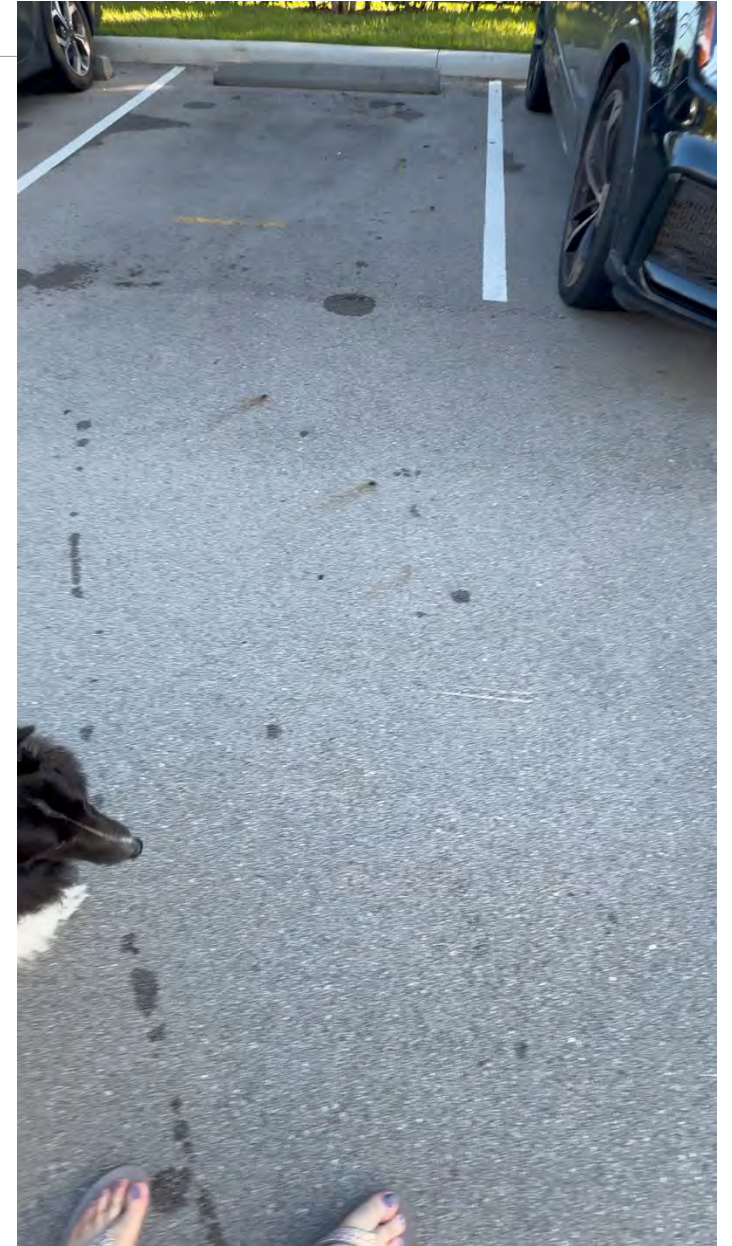
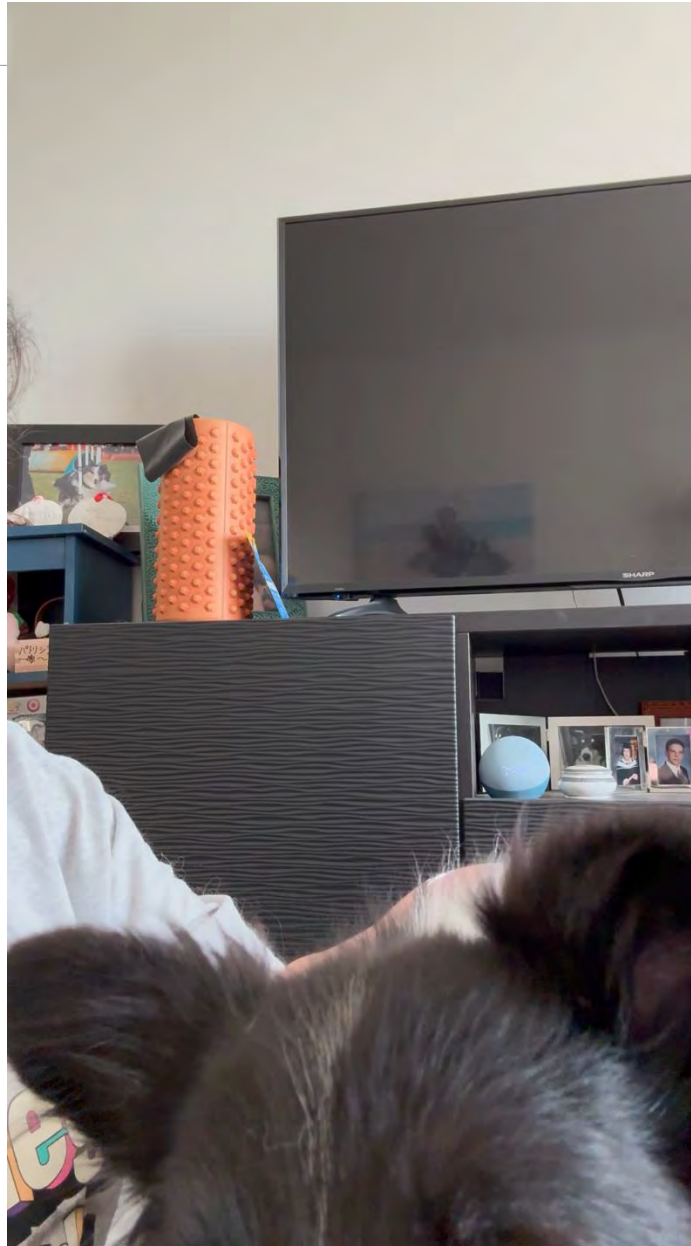
- Later in day of onset



✓ Case Study – Islay

Islay

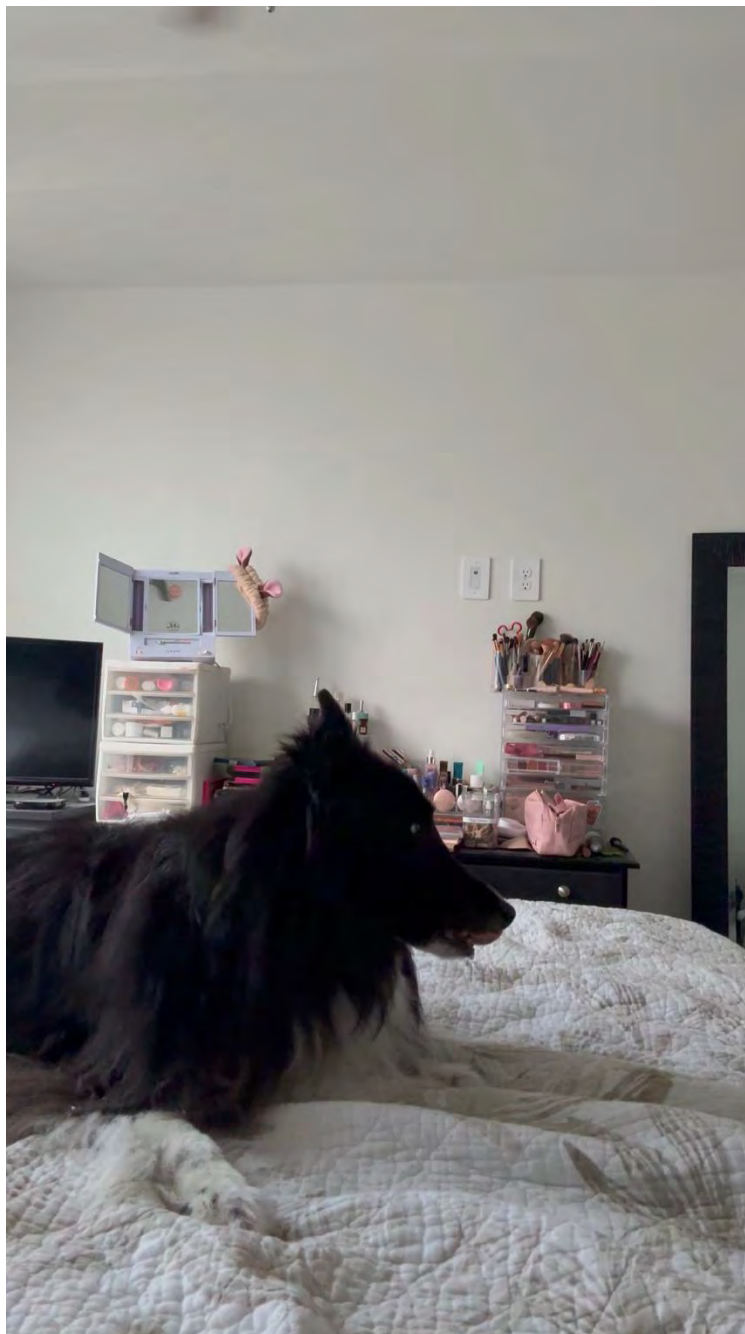
- Sept 1, 2025
- Trying to get her to follow for Alexander's law



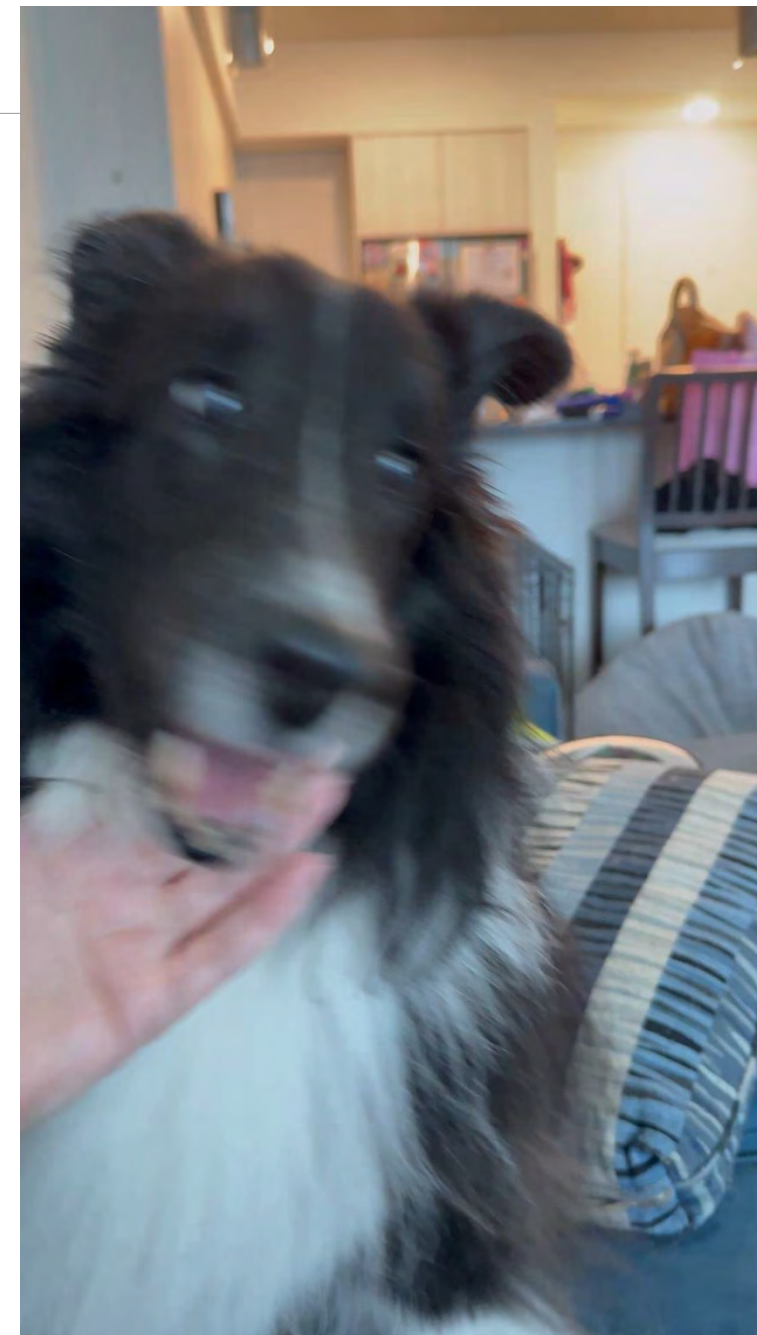
✓ Case Study – Islay

Islay

Sept 1



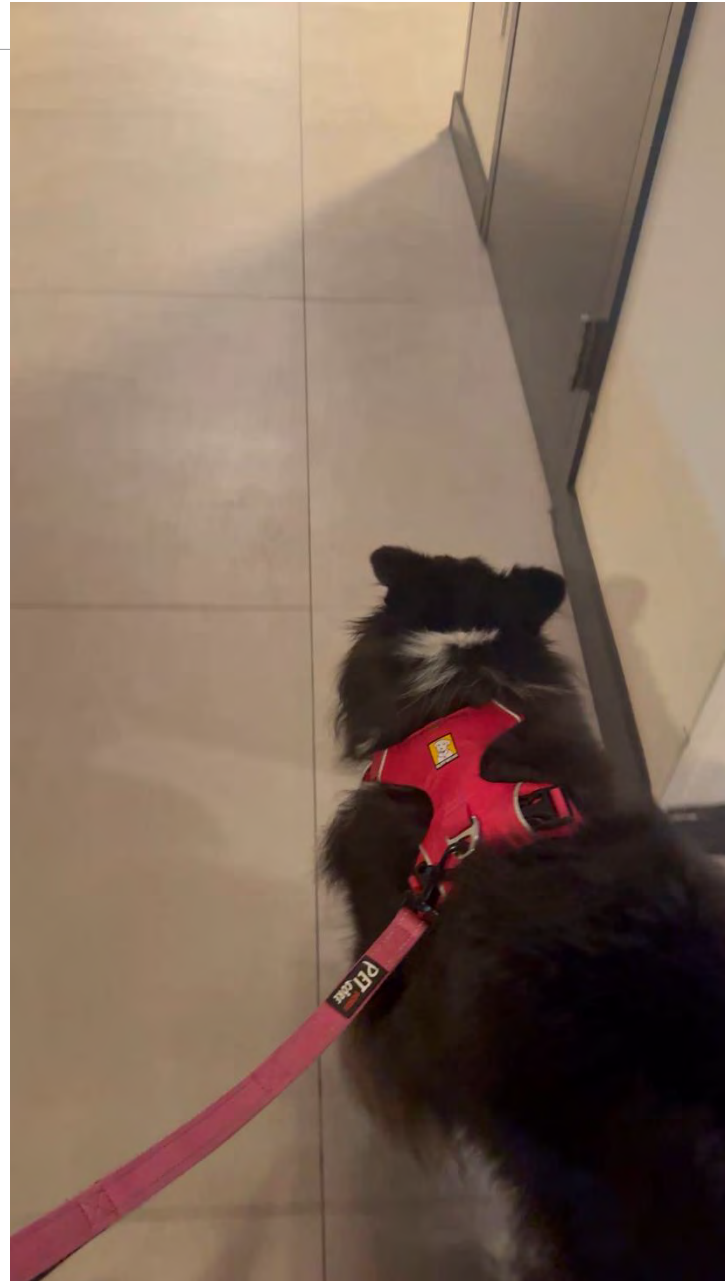
Sept 2



✓ Case Study – Islay

Islay

Sept 4

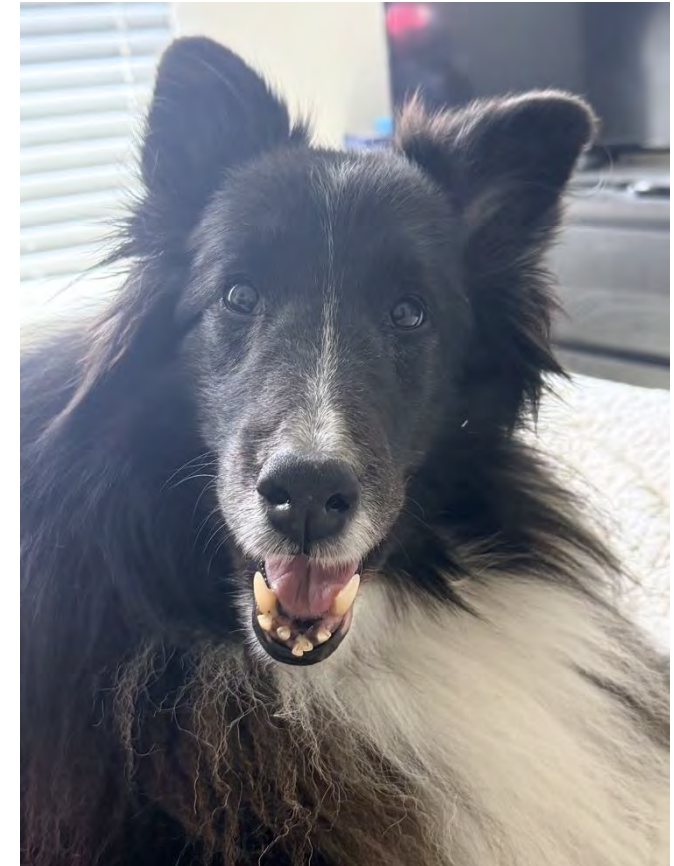


Sept 13

Islay



Dec 27



May 10, 2026

Summary and Considerations

- Many vestibular disorders seen in animals closely parallel those encountered in human patients, making comparative vestibular medicine a useful framework for understanding balance disorders across species.
- Opportunities to do comparative research
- More formalized assessments?

Thank you!

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