NEURORADIOLOGY: RADIOGRAPHS VS. COMPUTED TOMOGRAPHY (CT) VS. MAGNETIC RESONANCE IMAGINGE (MRI)

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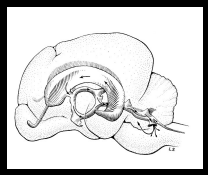
HYDROCEPHALUS

- Cause
  - Overproduction or obstruction to outflow of CSF
  - Congenital or acquired
- History, signalment and clinical signs
  - Young, toy breeds
  - Normal to dull mentation, seizures, incoordination
- Views (2)
  - Closed mouth VD and lateral
- Roentgen signs
  - Open fontanel
  - Widened suture lines
  - Lack of visualization on normal calvarial convolutions
  - Caudal displacement of osseous tentorium
  - Normal

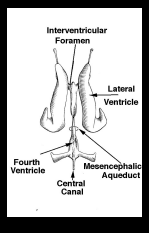
HYDROCEPHALUS

- Hydrocephalus can be either acquired or congenital
- Hydrocephalus is common in miniature breeds with dome shaped heads
  - Chihuahua
  - Manchester Terrier
  - Pekinese

CSF PRODUCTION AND FLOW



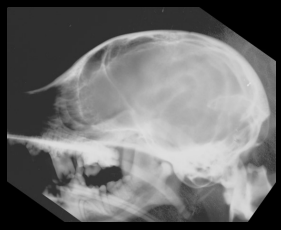
- Produced in the choroid plexus
- Flows through lateral ventricles, third ventricle, 4th ventricle, central canal and sub-arachnoid space



HYDROCEPHALUS

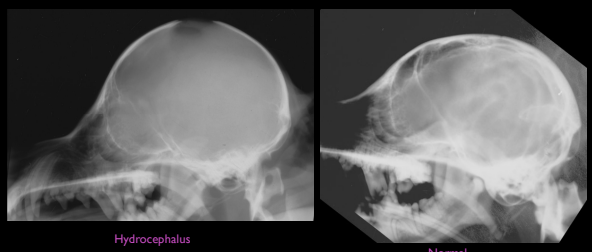
- Ground glass appearance
- Enlarged calvarium
- Thinned cortex
- Open fontanelles and sutures
- Caudal displacement of osseous tentorium
- Overall – RADIOGRAPHS ARE VERY INSENSITIVE FOR THE DIAGNOSIS OF HYDROCEPHALUS

HYDROCEPHALUS



- Digital impressions on the inter surface are cause by the gyri and sulci of the brain

Hydrocephalus

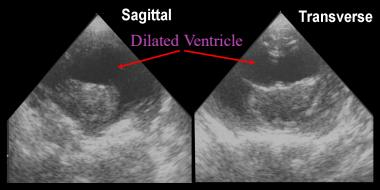


Hydrocephalus

Normal

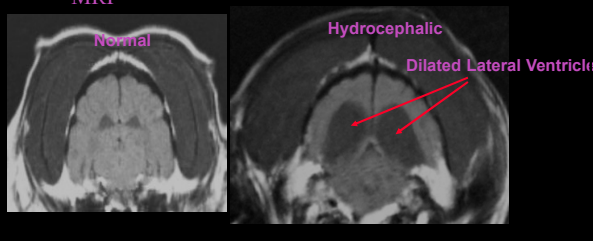
Hydrocephalus - Ultrasound

- Only possible if dorsal fontanelle is open



Hydrocephalus

- MRI



OCCIPITAL DYSPLASIA

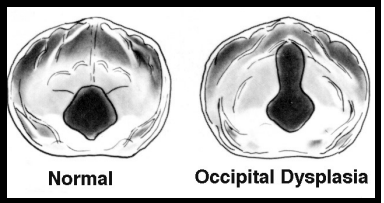
- Cause
  - Congenital defect of foramen magnum
  - 3 grades of severity
- History, signalment and clinical signs
  - Young, toy breeds
  - Normal to cervical pain to neurologic deficits affecting front/rear limbs
- Views (3)
  - Lateral, closed mouth VD, slight obliqued VD
- Roentgen signs
  - Abnormally formed foramen magnum with open dorsal extension causing "keyhole" shape

OCCIPITAL DYSPLASIA

- Occipital dysphasia is common in miniature breeds :
  - Toy breeds
  - Chihuahua
  - Yorkshire Terrier

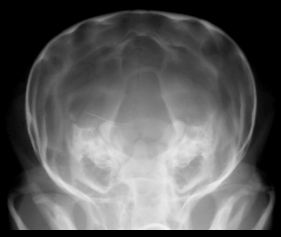
OCCIPITAL DYSPLASIA

- The foramen magnum will have a keyhole appearance



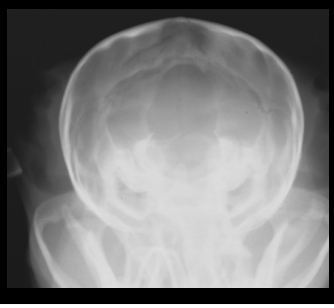
OCCIPITAL DYSPLASIA

- The foramen magnum will have a keyhole appearance
- Mild (type 1) – the dorsal aspect is thinner than the ventral aspect



OCCIPITAL DYSPLASIA

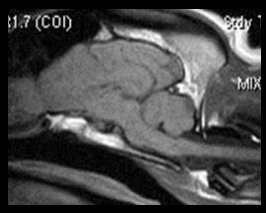
- The foramen magnum will have a keyhole appearance
- Severe (type 3) – dorsal aspect is wider than the ventral aspect



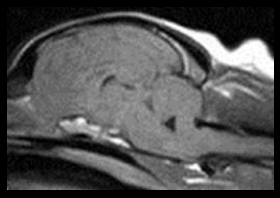
CHIARI SYNDROME

- Common in King Charles Cavalier Spaniels
- Caudal crowding of the cerebellum with herniation of a portion of the cerebellum being herniated through the foramen magnum
- Presents with neck pain, mentally dull and possible ataxia

CHIARI SYNDROME



Normal



Chiari Syndrome

CRANIAL MANDIBULAR OSTEOPATHY

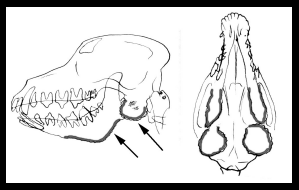
- Cause
  - Unknown, viral?
- History, signalment and clinical signs
  - <1 yr, any breed but Westies most common. Pain or inability to open mouth fully, muscle atrophy, weight loss
- Views (2)
  - Closed mouth VD and lateral view
- Roentgen signs
  - Osteoproductive lesion of mandible, TMJ's, bulla
  - NO lysis

CRANIAL MANDIBULAR OSTEOPATHY

- West Highland White Terriers
- Scottish Terriers
- Cairn Terriers
- Labradors Retrievers
- Doberman Pinschers
- German Shepards
- Other Breeds

CRANIAL MANDIBULAR OSTEOPATHY

- Periosteal new bone on the horizontal ramus of the mandible and the temporal bones near the TMJ



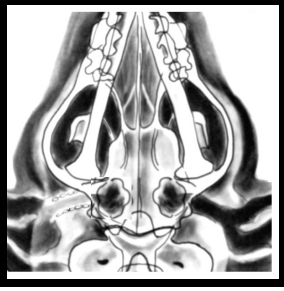
CRANIAL MANDIBULAR OSTEOPATHY

CRANIAL MANDIBULAR OSTEOPATHY

OTITIS

- An inflammation of the ear
  - Externa - refers to the external ear canal
  - Media - refers to the middle ear
  - Interna - refers to the inner ear

OTITIS EXTERNA

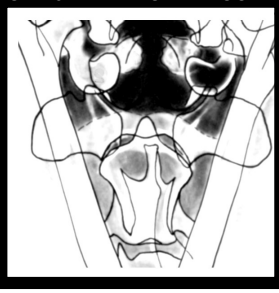


OTITIS MEDIA

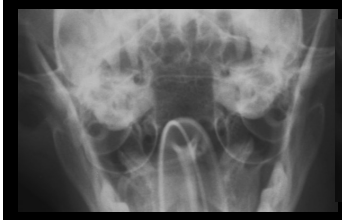
- Cause
  - Bacterial infection of middle ear, secondary to chronic otitis external
- History, signalment and clinical signs
  - Floppy eared dogs, older.
  - Head tilt, ear pawing, exudate, seizures if severe
- Views (4)
  - Closed mouth VD, open mouth VD, obliques
- Roentgen signs
  - Thick osseous bulla
  - Lysis of osseous bulla
  - Increased soft tissue density in bulla
  - Dystrophic mineralization of external ear canals

OTITIS MEDIA

OTITIS MEDIA – OPEN MOUTH VD OF BULLA



OTITIS MEDIA – OPEN MOUTH VD



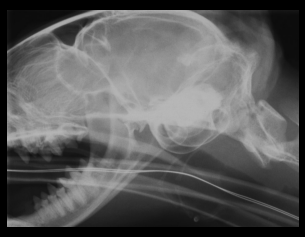
Normal

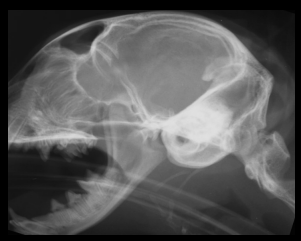
Otitis Media

NASOPHARYGEAL POLYP

- Can develop secondary to chronic otitis media
- Polyps can cause upper airway obstruction
- Young to middle age cats

NASOPHARYNGEAL POLYP AND OTITIS MEDIA





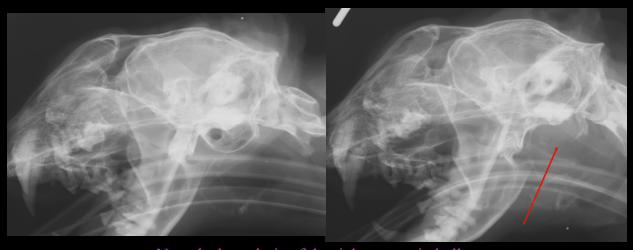
Normal

Nasopharyngeal Polyp

NEOPLASIA OF EAR CANAL

- Soft tissue opacity within the ear canal
- Bony lysis of the tympanic bulla or adjacent bony structures
- Unilateral involvement
- Dystrophic mineralization within the soft tissue mass

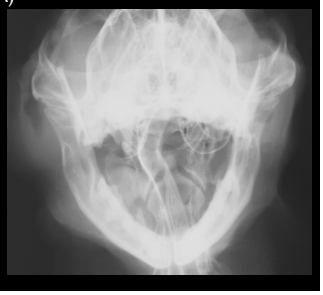
TUMOR OF THE EAR CANAL AND MIDDLE EAR



Note the bony lysis of the right tympanic bulla

TUMOR OF THE MIDDLE EAR (BULLA)

- Open mouth VD view of bullae



NASAL DISEASE

- Non-destructive rhinitis
  - Bacterial infection
  - Fungal infection – mycobacterium, cryptococcus, aspergillosis, blastomycosis
  - Lucent foreign body – grass
  - Allergic rhinitis
  - Parasitic disease – *Pneumonyssus caninum, Linguatula serrata*
  - Kartagener's syndrome – chronic sinusitis, bronchiectasis, situs inversus
- Destructive rhinitis
  - Neoplasia – adenocarcinoma, squamous cell carcinoma, lymphosarcoma
  - Fungal disease

NASAL DISEASE

History, signalment and clinical signs

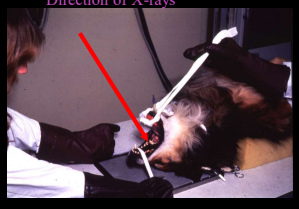
- Middle age to older
- Serous to mucopurulent discharge (non-destructive)
- Mucopurulent to bloody discharge (destructive)
- Views (3)
  - Open mouth VD, lateral, skyline frontal sinus

DISEASES OF NASAL PASSAGE

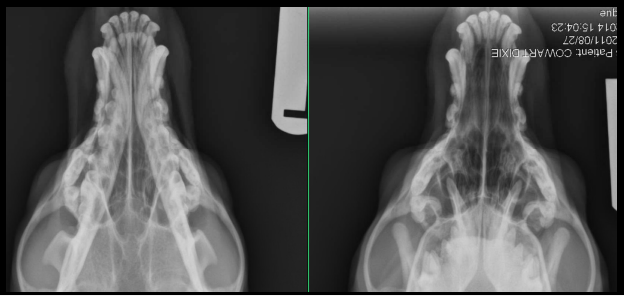
- Major portions of the nasal passage are inaccessible for direct visualization
- Radiographs are used to characterize the disease morphologically into two categories:
  - Destructive rhinitis
  - Nondestructive rhinitis

POSITIONING FOR OPEN MOUTH VD VIEW OF NASAL PASSAGE

Direction of X-rays

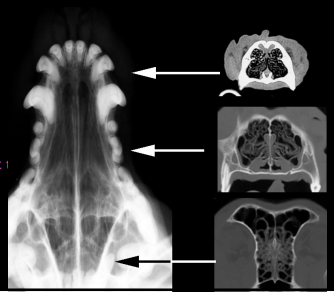


CLOSED VS. OPEN MOUTH VD



NORMAL APPEARANCE

- Compare
  - Radiograph on the left
  - CT images on the right
- Note the turbinate patterns at different levels



NONDESTRUCTIVE RHINITIS

- Etiologies
  - Bacterial rhinitis
  - Allergic rhinitis
  - viral rhinitis
  - Foreign body rhinitis
  - parasitic rhinitis
  - early tumor
  - early fungal rhinitis

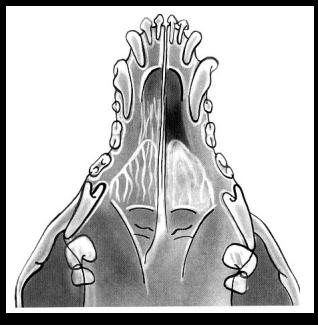
NON-DESTRUCTIVE RHINITIS

DESTRUCTIVE RHINITIS

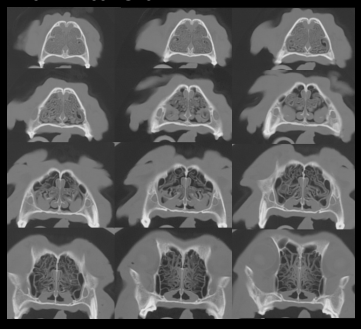
Etiologies

- Fungal Infections
  - Aspergillus
  - Penicillium
  - Cryptococcus
  - Actinomyces
- Neoplasia
  - Adenocarcinoma
  - Squamous cell carcinoma
  - Osteosarcoma
  - Lymphoma

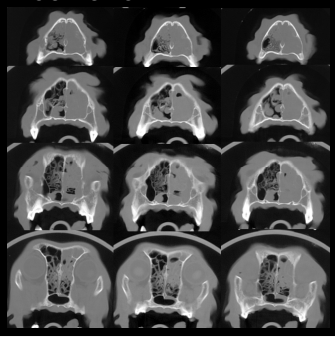
DESTRUCTIVE RHINITIS



CT OF NORMAL NASAL PASSAGES



CT OF NASAL ADENOCARCINOMA



FUNGAL VS INTRANASAL TUMOR

- Fungal Rhinitis
  - age - no predilection
  - Breed - no predilection
  - Size - medium to Lg
  - Discharge - mostly unilateral
  - Facial deformity - rare
  - External Mass - rare
- Intranasal tumor
  - age - older animals
  - Breed - dolichocephalic
  - Size - > 15Kg
  - Discharge - start unilat then progress to bilat
  - Facial deformity - yes
  - External mass - yes

ATLANTOAXIAL INSTABILITY

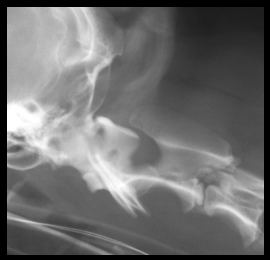
- Cause
  - Congenital malformation of dens (aplasia or hypoplasia), ligamentous malformation/laxity, trauma to dens
- History, signalment and clinical signs
  - Ataxia, paralysis, cervical pain
- Views (4)
  - Straight lateral C-spine, lateral dens view, slightly flexed lateral, VD
- Roentgen signs
  - Increased joint space width between caudal aspect of C1 and cranial aspect of dorsal spinous process of C2
  - Small or missing dens
  - Fractured dens

ATLANTOAXIAL INSTABILITY

Occurrence

- Atlantoaxial instability is common in miniature breeds :
  - Toy Poodles
  - Chihuahua
  - Pekingese
- Most affected dogs exhibit clinical signs before 1 year
- No sex predilection

ATLANTOAXIAL INSTABILITY



Normal

AA Instability

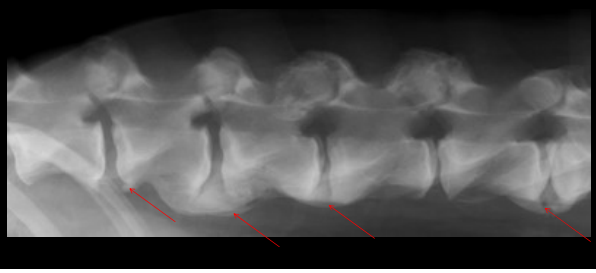
ATLANTOAXIAL INSTABILITY?

ATLANTOAXIAL INSTABILITY – GENTLY FLEXED

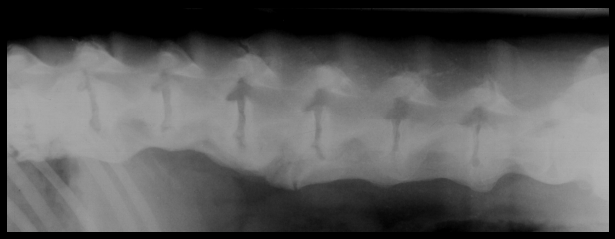
SPONDYLOSIS DEFORMANS

- Cause
  - Joint instability
- History, signalment and clinical signs
  - Any aged animal over about 1 year
  - No clinical signs, an incidental finding
- Views (2)
  - Lateral and VD
- Roentgen signs
  - Smoothly marginated, complete or incomplete bony bridging along ventral and/or lateral aspect of vertebral bodies
  - Contiguous or intermittent involvement

SPONDYLOSIS DEFORMANS (BRIDGING)



SPONDYLOSIS DEFORMANS (COMPLETE BRIDGING – DISH)



DISCOSPONDYLITIS

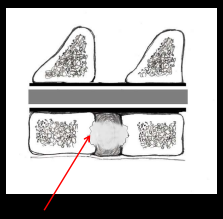
- Cause
  - Bacterial infection of intervertebral discs and end plates (staph, strep, e coli, brucella)
  - May be secondary to bladder, prostate, uterine infection
- History, signalment and clinical signs
  - Young dogs and cats, <2 years most commonly
  - Moderate to severe back pain, reluctance to move or ambulate, neuro deficits to limbs in severe cases
- Views (2)
  - Lateral and VD of entire spine
- Roentgen signs
  - Osteolytic focal lesion involving adjacent vertebral end plates
  - Widened or narrowed intervertebral disc space
  - Commonly involves more than one site

DISCOSPONDYLITIS

- Discospondylitis is common in large and giant breeds
  - German Shepherds
  - Great Danes
- Age range - 4-5 years most common
- Sex - Males more common than female

DISCOSPONDYLITIS

- Thoracic and lumbar spine are the most common sites
- Disease is characterized by irregular lysis of the vertebral endplates

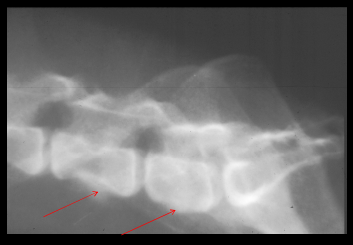


SEVERE DISCOSPONDYLITIS

SPONDYLITIS

- Cause
  - Bacterial infection of ventral aspect of the vertebral body (staph, strep, e coli, brucella)
  - May be secondary to bladder, prostate, uterine infection
- History, signalment and clinical signs
  - Middle age to older dogs and cats, <2 years most commonly
  - Moderate to severe back pain, reluctance to move or ambulate, neuro deficits to limbs in severe cases
- Views (2)
  - Lateral and VD
- Roentgen signs
  - Loss of concave margin of ventral aspect of vertebral body
  - Bony productive lesion on ventral aspect of vertebral body with roughened appearance
  - May affect more than one site

SPONDYLITIS



Note the new bone formation along the ventral vertebral bodies

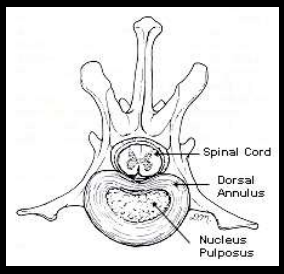
INTERVERTEBRAL DISC DISEASE

- Cause
  - Type I or 2, IV disc protrusion or extrusion of nucleus pulposis
- History, signalment and clinical signs
  - Middle age to older, chondrodystrophoid breeds
  - Pain to complete paralysis affecting front, rear or all four limbs
- Views (2)
  - Lateral (straight) and VD (straight)
- Roentgen signs
  - Narrowed intervertebral disc space
  - Narrowed intervertebral foramen
  - Mineralized disc shell *in situ*
  - "Missing" mineralized disc
  - Increased soft tissue opacity in intervertebral foramen
  - Wedged intervertebral disc space
  - Good luck in C-spine on plain films alone
  - Often requires myelography

INTERVERTEBRAL DISC DISEASE

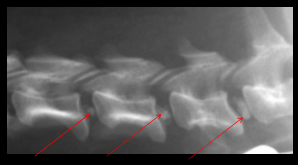
Anatomy

- Composed of an outer annulus fibrosis and an inner nucleus pulposus



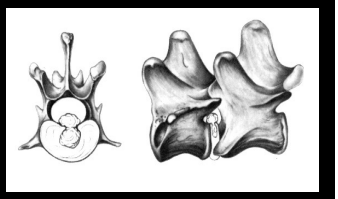
MINERALIZED DISCS

- Intervertebral disc is mineralized
- Disc may still be in the normal anatomic position and could be incidental
- Some of these discs may extrude (herniate) or protrude
- Often times incidental



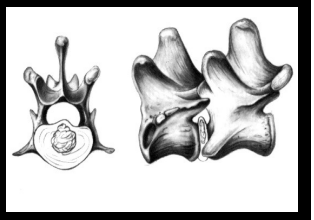
INTERVERTEBRAL DISC HERNIATION

- Hanson Type I
  - Chondrodystrophoid breeds
  - Chondroid metamorphosis
  - Degeneration and calcification, acute herniation of nucleus pulposus

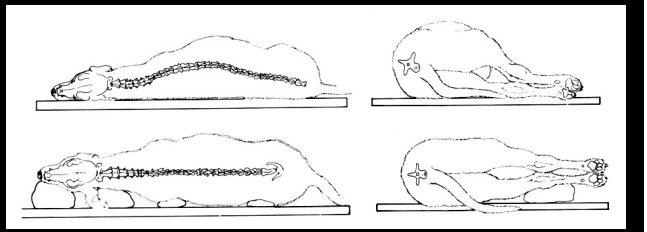


INTERVERTEBRAL DISC HERNIATION

- Hanson Type II
  - Non-chondrodystrophoid
  - Fibroid metamorphosis
  - Incomplete annular rupture, or annular protrusion
  - Slower onset, milder signs

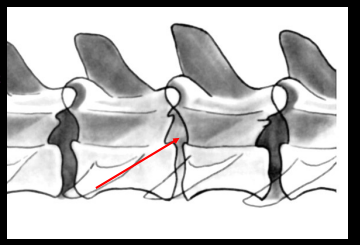


POSITIONING IS CRITICAL FOR THE SPINE

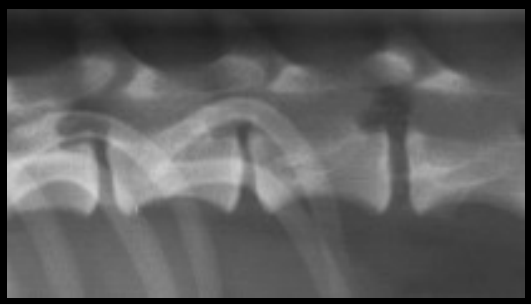


INTERVERTEBRAL DISC HERNIATION

- Narrowed/wedged intervertebral disc space
- Narrowed intervertebral foramen
- Narrowed dorsal facet
- Increased opacity in the intervertebral foramen



Intervertebral Disc Herniation?



VERTEBRAL TUMORS

Occurrence

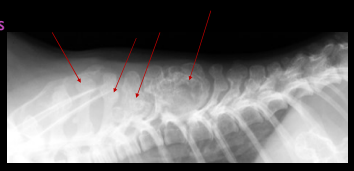
- Both primary and metastatic tumors affect the vertebral column
- Primary tumors may originate from either the bone or neural tissue.
- Primary tumors are usually located in only one vertebral body

VERTEBRAL BODY TUMORS

- Majority are lytic in nature
- Common tumor types
  - Osteosarcoma
  - Chondrosarcoma
  - Fibrosarcoma
  - Lymphoma
  - Multiple myeloma

PRIMARY VERTEBRAL BODY TUMORS – MCE (BENIGN)

- Osteochondroma or multiple cartilaginous exostoses (MCE) is an exception.
  - Multiple vertebrae and/or ribs can be involved
  - Characterized by multiple well circumscribed bony masses



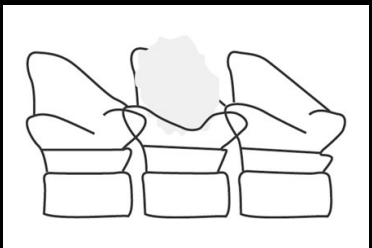
METASTATIC NEOPLASIA OF VERTEBRAL COLUMN

- Often involve more than one vertebral body
- Vertebral column is one of the more common locations but also seen in:
  - ribs
  - pelvis
  - skull
  - long bones

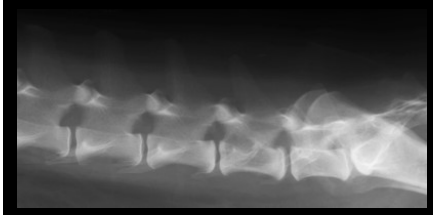
METASTATIC NEOPLASIA OF SPINAL COLUMN

- Lesion may be lytic but periosteal reactions may also be seen
- The primary tumor may be:
  - prostatic
  - bladder
  - urethral
  - mammary
  - perianal neoplasia

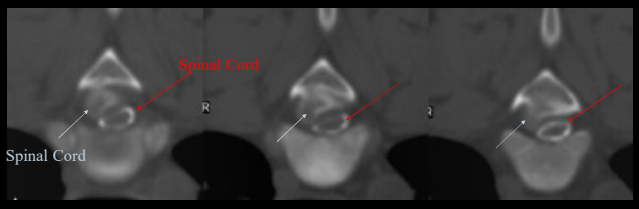
VERTEBRAL NEOPLASIA (OSTEOSARCOMA MOST COMMON)



VERTEBRAL BODY TUMOR?



MULTIPLE CARTILAGINOUS EXOSTOSES (MCE)



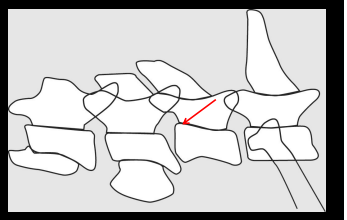
CT scan showing bony mass displacing and compressing the Spinal cord

CERVICAL VERTEBRAL INSTABILITY (WOBBLER'S DISEASE)

- Cause
  - Complex syndrome, cervical disc spaces are unstable leading to impingement of spinal cord by dorsally displaced vertebral body, hypertrophy of dorsal longitudinal ligament or IV disc protrusion/extrusion
- History, signalment and clinical signs
  - Great Danes, Dobermans, middle to older
  - Ataxia, cervical pain, hemi to tetraparesis, wide based stance
- Views (2)
  - Straight lateral and VD
- Roentgen signs
  - Narrowed intervertebral disc space*
  - Dorsal deviation of cranial-dorsal aspect of vertebral body
  - Wedged IV disc space
  - Remodeled or "planed" appearance of cranioventral vertebral body
  - Most common site is C5-6, then C6-7 followed by C4-5
  - Usually requires myelography and dynamic views

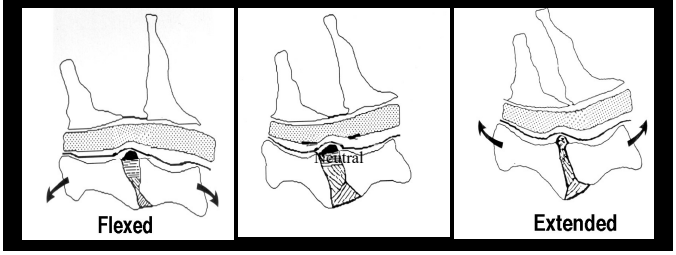
RADIOGRAPHIC FINDINGS:

- Dorsal tipping of cranial aspect of a vertebral body
- "Shaved Off" appearance of cranial ventral aspect of the vertebral body
- Mild spinal malalignment



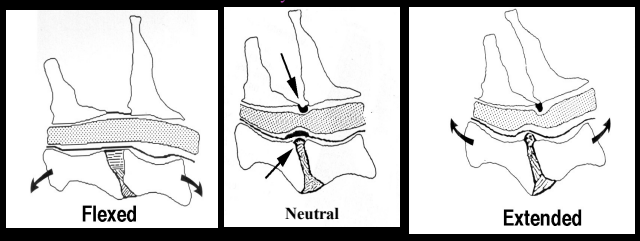
CERVICAL VERTEBRAL INSTABILITY (WOBBLER'S DISEASE)

Static Lesion



CERVICAL VERTEBRAL INSTABILITY ("WOBBLER'S DISEASE)

Dynamic Lesion

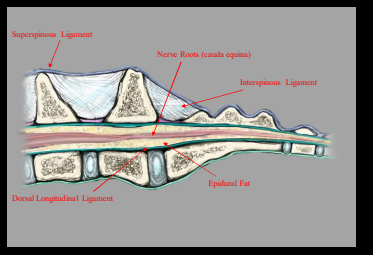


LUMBOSACRAL INSTABILITY (CAUDA EQUINA SYNDROME)

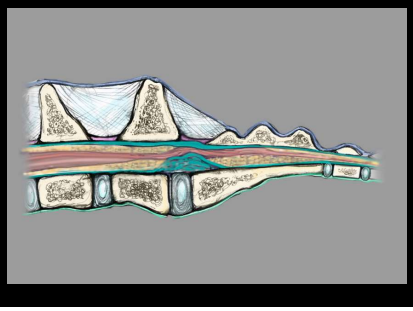
- Cause
  - Instability of L7-S1 leading to IV disc protrusion or extrusion and/or hypertrophy of dorsal longitudinal ligament
  - Transitional vertebrae may predispose
- History, signalment and clinical signs
  - Middle to older dogs (Germ. Shep)
  - Rear limb ataxia, worn dorsal nails, pain during full extension of pelvis, reluctance to position to defecate
- Views (2)
  - Lateral and VD
- Roentgen signs
  - Narrowed IV disc space at L7-S1
  - Wedged disc space at L7-S1
  - Spondylosis at L7-S1
  - Ventral step lesion at L7-S1 (cranial aspect of S1 ventrally displaced compared to L7)
  - Full colon

LUMBOSACRAL INSTABILITY

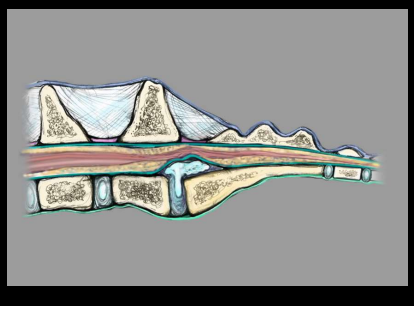
- Lumbosacral instability is due to congenital or acquired biomechanical changes that result in the neurologic syndrome know as Cauda Equina Syndrome



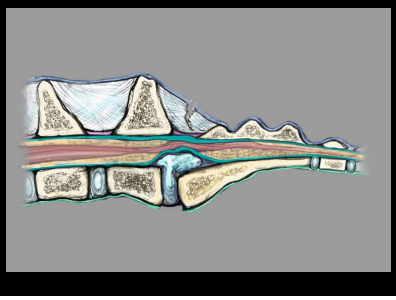
HYPERTROPHY OF DORSAL LONGITUDINAL LIGAMENT



DISC EXTRUSION AT L7-S1

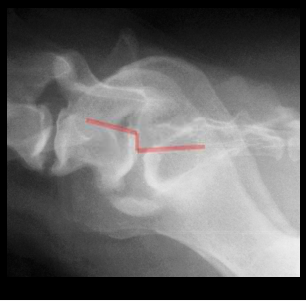


DISC EXTRUSION AND VENTRAL SUBLUXATION



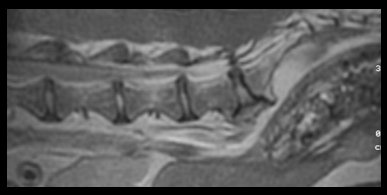
LS STEP LESION

LS STEP LESION

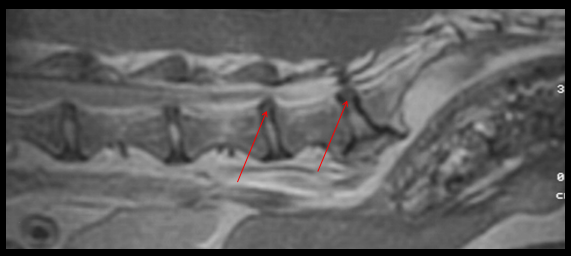


MAGNETIC RESONANCE IMAGING

- Optimal imaging technique
- Lateralized lesions
- Degenerative discs



MAGNETIC RESONANCE IMAGE – LS DISEASE



SEIZURE PATIENT

- Will skull radiographs help to make the diagnosis?
  - Almost always normal
  - No!
  - Rule out liver disease, infectious disease
  - Nearly all causes of seizures will be caused by something that only MRI (and possibly CT) can diagnose

SUMMARY

- Radiographs can absolutely make the diagnosis
  - Atlantoaxial instability (AA)
  - Cranial mandibular osteopathy (CMO)
  - Spondylosis deformans
  - Discospondylitis
  - Spondylitis
- Radiographs might help to make the diagnosis (but CT is better)
  - Occipital dysplasia
  - Otitis media and externa
  - Nasopharyngeal polyp
  - Nasal neoplasia or fungal disease

SUMMARY

- CT can make the diagnosis in most cases
  - Vertebral neoplasia
  - Nasal infection and neoplasia
  - Nasopharyngeal polyp
  - Occipital dysplasia
  - Middle ear infections and neoplasia
  - Intervertebral disc disease
    - Will require pre and post myelogram CT though
- MRI will be required make the diagnosis
  - Chiari syndrome
  - Brian tumors
  - Lumbosacral stenosis
  - IV disease disease
  - Cervical vertebral instability ("Wobbler's disease)
  - Lumbosacral disease