Pathology of the Hematopoietic System

Lecture 3: Thymus and Spleen

Enrique Aburto, March 2014
Thymus – Structure and function

• White to pink, lobulated organ within the anterior mediastinum
• Ruminants and pigs have a large cervical lobe that extends along the cervical trachea
Thymus – Structure and function

• **Structure**
  – Composed of **epithelial tissue** and **lymphoid tissue**
  – Lobulated and split into cortical and medullary areas

• **Function**
  – Proliferation & maturation of T cells

Thymus – Miscellaneous diseases

**Miscellaneous diseases**

- Thymic aplasia/hypoplasia
- Lymphocytolysis/thymic atrophy
- Thymic hemorrhage/hematoma

**Congenital immunodeficiency**: Foals, mice, dogs (jack Russell terriers & Basset hounds)

**Can lead to acquired immunodeficiency**: Due to: malnutrition, drugs/toxins, viral infections, advancing age

More susceptible to opportunistic pathogens & more severe infections in both cases

*Severe combined immunodeficiency (SCID)*
Thymic aplasia/hypoplasia

Lymphocytolysis/thymic atrophy

Thymic hemorrhage/hematoma

Thymic hemorrhage:
- In dogs, sudden death is occasionally seen due to hypovolemic shock resulting from massive thymic/mediastinal hemorrhage
- Several implicated causes: trauma, ruptured aorta, anticoagulant rodenticide

From Noah’s arkive
Thymus – Primary neoplasia

General Features:
- Space occupying mass in cranial mediastinum
- Dyspnea
- 2 main differentials
Thymic Lymphoma
Neoplastic proliferation of T-lymphocytes
Often younger animals (cats, calves, and dogs)
Malignant behaviour

Thymoma
Neoplastic proliferation of epithelial cells
Less common – dogs, sheep, goats
Slow growing, encapsulated
Spleen – Structure and Function

- Present in the left cranial part of the abdomen within the greater omentum
- Attached to the greater curvature of the stomach
- Covered by a fibromuscular capsule and dissected by fibromuscular trabeculae
- Varies in size and shape among species

Normal spleen from a cat
## Spleen – Structure and Function

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
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</table>
| **Red Pulp**       | • Sinusoids/vascular spaces  
|                    | • Splenic cords  
|                    | • Filters blood -  
|                    |  removal of foreign material  
|                    |  (phagocytosis)  
|                    | • RBC storage  
|                    | • Hematopoiesis (EMH)  |
| **White Pulp**     | • Periarterial lymphatic sheaths (PALS) (T-cells)  
|                    | • Lymphoid nodules (B-cells)  
|                    | • Marginal zone (Macrophages)  
|                    | • Immune response |
Diseases of the spleen

1. Miscellaneous Diseases
2. Circulatory diseases of the spleen
3. Inflammation of the spleen (splenitis)
4. Adaptations of growth
   - Aplasia/Hypoplasia, Hyperplasia, Atrophy
5. Primary and secondary splenic neoplasia
<table>
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<td>Splenic Contraction</td>
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Spleen – Miscellaneous diseases

Siderofibrosis = Gamna-Gandy bodies

- Incidental finding/senile change
- Possible sequela of prior hemorrhage

Gross: Granular white-yellow deposits in the splenic capsule
Spleen – Miscellaneous diseases

Siderofibrosis = Gamna-Gandy bodies

- Incidental finding/senile change
- Possible sequela of prior hemorrhage

Histo: Hematoidin, hemosiderin and mineral deposits
Splenic amyloidosis

- Usually 2° amyloidosis - chronic inflammation
- Gross: Splenomegaly, beige to orange discolouration
**Splenic contraction**

- Contraction of the smooth muscle in the capsule/trabeculae
- Occurs with catecholamine release, shock, acute splenic rupture
- Gross: Small dry spleen with wrinkling of the capsule

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**Normal spleen**
### Splenic contraction

- Contraction of the smooth muscle in the capsule/trabeculae
- Occurs with catecholamine release, shock, acute splenic rupture
- Gross: Small dry spleen with wrinkling of the capsule

Contraction can be incomplete: Grossly, looks very similar to splenic infarction
**Spleen – Miscellaneous diseases**

### Splenic contraction

- Contraction of the smooth muscle in the capsule/trabeculae
- Occurs with catecholamine release, shock, acute splenic rupture
- Gross: Small dry spleen with wrinkling of the capsule

**Compare to splenic infarction**

Contraction can be incomplete:
Grossly, looks very similar to splenic infarction
Splenic rupture

- Fairly common
- Primary - trauma
- Secondary to splenomegaly, splenic neoplasia
- Potential sequelae include hemoabdomen and splenosis

Splenic rupture 2 to hemangiosarcoma in a dog

Splenic rupture and hemoabdomen 2 to splenomegaly (lymphoma) in a pig
Splenic rupture → splenosis

- Seeding of splenic explants on peritoneal surfaces forming accessory spleens

Gross: Small red nodules within the omentum

Can be mistaken for hemangiosarcoma metastases

Image: Cornell Veterinary Medicine
Spleen – Miscellaneous diseases

Splenic rupture → splenosis

- Seeding of splenic explants on peritoneal surfaces forming accessory spleens

Gross: Small red nodules within the omentum

Histology: Look like small (normal) spleens

Image: Cornell Veterinary Medicine
Spleen – Miscellaneous diseases

**Splenic torsion**

- Dogs and pigs
- With or without the stomach (GDV*)
- Twists around the gastrosplenic ligament

**Gross:** Splenomegaly, blue to black, folded back on itself
### Circulatory disturbances

- Active hyperemia
- Passive congestion
- Splenic infarction
- Splenic hematoma
Congested vs normal spleen

**Active hyperemia**
- Acute systemic infection

**Passive congestion**
- Vascular pooling (shock)
- Barbiturate administration**
- Hemolytic anemia

**Similar grossly:**
- Splenomegaly
- Red to purple
- Oozes blood on cut surface
Spleen – Circulatory disturbances

Active hyperemia
- Acute systemic infection

Passive congestion
- Vascular pooling (shock)
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Similar grossly:
- Splenomegaly
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College of Veterinary Medicine, University of Illinois
Spleen – Circulatory disturbances

Splenic congestion from barbiturate euthanasia in a horse – **marked splenomegaly**

**Histology:** Red pulp dilated and contains blood; the white pulp is widely separated

Dr MD McGavin, College of Veterinary Medicine, University of Tennessee
**Gross Lesions:**
Acutely: infarcts are discrete, raised, and dark red – at the margins of the organ
With time: pale and firm (fibrosis)

**Spleen – Circulatory disturbances**

**Splenic Infarcts:**
Ischemic necrosis of the spleen

1. Vascular damage
2. Hypercoagulable states
3. Splenomegaly (of any cause)
4. Septic emboli

Due to thrombosis
Spleen – Circulatory disturbances

**Splenic hematoma**

- Common in dogs
- Trauma
- Often associated with nodular hyperplasia or vascular tumours

Need histology to rule out underlying neoplasia!

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**Gross:** Red nodular mass. Often very large, soft and dark red on cut surface
Spleen – Inflammation

Acute splenitis – Multifocal necrosuppurative splenitis

Tularemia (Francisella tularensis)
Yersiniosis (Yersinia pseudotuberculosis)

Gross: Multifocal miliary white foci within the spleen.
• Can see similar lesions in the lymph nodes and liver
• Older lesions resemble granulomas/abscesses

Images courtesy of Dr Daoust
Acute splenitis – Septicemic splenitis

- African swine fever
- Erysipelas
- Anthrax**

Gross Findings
- Splenomegaly
- Dark discoloration
- Engorged with viscous blood
Acute splenitis – Septicemic splenitis - ANTHRAX

- A disease caused by a spore forming bacterium: *Bacillus anthracis*
  - Zoonotic
  - In horses, pigs and dogs – pharyngeal and enteric disease
  - In ruminants – septicemic disease
Anthrax – Pathogenesis in ruminants:

- Ingestion / wound contamination / inhalation of spores
- Lymphangitis and localized lymphadenitis
- Massive bacteremia (sepsis) and toxemia
- Increased vascular permeability and impaired coagulation
- Sudden Death

- With sepsis, huge numbers of vegetative organisms in blood
- Become spores when exposed to air
  - Very resistant
  - Survive decades in soil
  - Infections often occur following soil excavation

Spleen – Inflammation

Spleen – Inflammation

Spleen – Inflammation
Spleen – Inflammation

Anthrax - Lesions in ruminants
Spleen – Inflammation

Anthrax - Lesions in ruminants

Characteristic Findings:

• Bloated autolysed carcass with blood oozing from the orifices

• You aren’t supposed to necropsy suspect cases!!

• Take a blood smear from the ear!

• Methylene blue stain: Short chains of large bacilli with distinct pink capsule and square ends
Marked splenomegaly: Dark red to black, soft to semi-fluid spleen

Multifocal hemorrhage and edema in connective tissue

Thick tarry blood: fails to clot

Potential for bioterrorism?
Spleen – Inflammation

**Chronic splenitis: Granulomatous splenitis**

- Nodular granulomatous splenitis:
  - *Mycobacterium avium* infection in a chicken
  - Images: Dr Fenton

- Diffuse granulomatous splenitis:
  - Histoplasmosis in a dog
  - Dept of Veterinary Biosciences, The Ohio State University
### Spleen – Disturbances of growth

**Growth disturbances**

- Aplasia
- Atrophy
- Benign nodular hyperplasia
- Lymphoid hyperplasia
- Hyperplasia of the monocyte-macrophage system
- Extramedullary hematopoiesis
Spleen – Disturbances of growth

Benign nodular hyperplasia

- Common finding in old dogs
- Usually incidental
- May predispose to splenic hematomas

Gross: Gray to red nodular mass(es): composed of lymphoid tissue and red pulp

Importance: Rule-out neoplasia

Images: Dr MD McGavin, College of Veterinary Medicine, University of Tennessee
Spleen – Disturbances of growth

**Lymphoid hyperplasia**
- Hyperplasia of the white pulp
- Response to blood-borne antigen/chronic antigenic stimulation

Lymphoid follicles visible as 1 – 3 mm foci

**Lymphoid hyperplasia, Malignant Catarrhal Fever, Bovine**

From Noah’s arkive
**Primary splenic neoplasia**

Lymphoproliferative diseases:
- Lymphoma/Leukemia*

Myeloproliferative diseases:
- Histiocytic sarcoma*
- Mastocytosis*

Hemangioma

Hemangiosarcoma

Others: Fibrosarcoma, Fibrohistiocytic nodules, etc

* Covered in primary hematopoietic neoplasia
Splenic hemangioma

- Benign tumour of endothelial origin

Gross: Single, soft, dark red nodular mass

This looks very similar to splenic hematoma and hemangiosarcoma! Histology is necessary!
Splenic hemangiosarcoma
- Most common malignant tumour of the canine spleen

Gross:
- Single to multiple, discrete to coalescing masses
- Often dark red
- +/- metastases
Splenic hemangiosarcoma

- Most common malignant tumour of the canine spleen

**Histology:**
- Blood-filled vascular spaces lined by anaplastic endothelial cells
Splenic hemangiosarcoma

- Most common malignant tumour of the canine spleen

Possible sequelae: Splenic rupture, hemoabdomen, peritoneal seeding, metastasis

Often there are concurrent masses in the right auricle and liver
Metastatic splenic tumours: dogs with pancreatic carcinoma (top) and mammary gland carcinoma (bottom)
### Red Splenic Nodules

**Splenic nodules**

- Hematoma
- Hemangioma
- Hemangiosarcoma
- Splenic infarcts
- Incompletely contracted areas of the spleen
- Nodular hyperplasia (not always red)
Diffuse Splenomegaly

Diffuse splenomegaly with a bloody consistency = Bloody Spleens

- Septicemia
  - Anthrax, Salmonella
- Acute hemolytic anemia
- Splenic torsion
- Barbiturate euthanasia*

Diffuse splenomegaly with a firm consistency = Meaty Spleens

- Septicemia
  - Salmonella
- Hemolytic disease
- Lymphoma
- Mast cell neoplasia
- Histiocytic sarcoma
- Granulomatous disease
  - Histoplasmosis
- Amyloidosis
Tonsils and Mucosa-Associated Lymphoid Tissue (MALT)

- Tonsillitis in a pig
- Tonsil Lymphoma in a dog

- Subject to similar disease processes as the LNs
- Constantly stimulated
- Important site of entry for pathogens