Spleen and thymus

Lymphoid Organs

Thymus Gland

Spleen

Tonsils and adenoids

Lymph nodes

Bone marrow

Lymph nodes

Appendix

Spleen

Peyer’s patches

Bone marrow

Lymphatic vessels
Lymphoid organs

- **Primary (central) lymphoid organs**
  - *Thymus*
  - Bone marrow = *Medulla ossium*

- **Secondary (peripheral) lymphoid organs**
  - *Spleen = Spleen (lien)*
  - Lymph nodes = *Nodi lymphoidei*
  - Tonsils = *Tonsillae*
  - Lymph nodules *lymphoidei*
Thymus - history

• 2nd cent. - Galen: „organ of mystery“
• 19th cent.
  – fills space between the lungs
  – blamed for sudden death infant syndrome („thymic asthma“; „status thymolymphaticus“)
• 1905 - first „successful treatment“ by radiotherapy
• 1961 - discovery of the function of the thymus by Jacques Miller
• 1974 - John Caffey:
  – „most mistakes I’ve seen were not because one didn’t know some disease, but because he didn’t know he was looking at normal.“
Thymus

- lymphoepithelial organ
- primary lymphoid organ
- lobus dx. et sin.
- lobuli, cortex, medulla
- (lobuli thymici accessorii)
- relatively largest after birth (12-14g)
- begins to atrophy in puberty
- remnants still evident in older age

© David Kachlík 30.9.2015
mediastinum superius behind sternum 20-50 g

newborn 16 g (10-35 g) from below thyroid gland down to pericardium

- successive atrophy from puberty
- replaced with adipose tissue after 50th year of age (5-15 g)
Thymus

- mediastinum superius (1st layer)
- covered with mediastinal connective tissue
case-report

age: 2 month
dg: coarctation of aorta

© David Kachlík 30.9.2015
Thymus – blood vessels

• branches from:
  – a. thyroidea inf.
  – thoracica int. (a. pericardiacophrenica)
  – arcus aortae

• non-fenestrated capillaries

• haematothymic barrier
  = clastrum haematothymicum
  – cortex
  – endothelium of capillaries
  – basal lamina of capillaries (+ pericytes, resp.)
  – connective tissue layer (+ macrophages)
  – basal lamina of reticular cells
  – reticular cells

© David Kachlík 30.9.2015
Thymus - development

Maxillary Prominence
Mandibular Prominence
Clefts
Pouches
Ext. auditory meatus
Prim. tympanic cavity
Auditory tube
Palatine tonsil
Parathyroid gland (Inf.)
Thymus
Parathyroid gland (sup.)
Cervical sinus
Ultimobranchial body

© David Kachlík 30.9.2015
Thymus - development

- ventral process of 3rd (and 4th) pharyngeal pouch
- mediocaudal descent (4th-7th week)
- endoderm proliferation
- 10th week: colonization with stem cells (lymphocytes) from blood islets, liver and bone marrow
- connective tissue septa ingrow from mesenchyme

© David Kachlík 30.9.2015
Thymus - structure

- covered with mediastinal connective tissue
  - contains vessels
  - grows into thymic tissue – false lobules
    - septa corticalia → lobuli thymici

- *cortex thymi*
  - darker apperance

- *medulla thymi*
  - lighter apperance
Thymus

HE

(x 15)
Thymus - cortex

- reticular epithelium (*cytoreticulum corticale*)
  - epitheliocyti reticulares (stellate cells connected with desmosomes) – typy I-III
  - they form a spatial network
  - macrophages a thymocytes nurse cells

- thymocytes (small and frequent)
  - mainly T-lymfocytes
  - rapidly multiply during development
    - cellula thymocytopoietica progenetrix → prothymocytus
    → thymocytus corticalis

© David Kachlík 30.9.2015
Thymus - cortex

HE (x 480)

immunoperoxidase (x 100)

© David Kachlík 30.9.2015
Thymus - medulla

- reticular epithelium (*cytoreticulum medullare*)
  - type IV-VI
- *thymocyti medullares* (small and middle)
  - not so densely
- *corpuscula thymica* (Hassal‘s bodies)
  - 30-150 μm
  - concentric layers of flattened reticular cells
  - keratinization, karyolysis
  - arise and fade out repetitively
- noduli lymphoidei thymici
- dendritic cells
  - antigen-presenting cells (APC)
- myoid cells
  - function not clear, possible role in pathogenesis of myastenia gravis

© David Kachlík 30.9.2015
Thymus medulla

HE (x 480)

© David Kachlik 30.9.2015
Thymus - histophysiology

• multiplication of T-lymfocytes
  – they leave thymus via medulla (10 %)
  – travel to lymph nodes, Peyer’s patches, spleen
• many growth factors → proliferation and differentiation of T-lymfocytes
• corticoids and sexual hormones suppress proliferation and accelerate involution

© David Kachlík 30.9.2015
Thymus - developmental disorders

- aplasia thymi
- aplasia thymoparathyroidea (DiGeorge's syndrome)
- few B-, no T-lymfocytes
- ectopia thymi
- hypoplasia thymi (Sprintzen's syndrome)
- textus thymicus accessorius intrapericardial
  accessory thymic tissue situated ventral to aorta ascendens

© David Kachlík 30.9.2015
DiGeorge's syndrome
Aplasia thymoparathyroidea
syndrome of 22q11.2 deletion
1:3000

DiGeorge Syndrome
= Basal Ganglia and Periventricular Calcification
+ Cardiac (tetralogy of Fallot)
+ Abnormal facies
+ Thymic aplasia
+ Cleft palate

© David Kachlík 30.9.2015
Spleen (splen, lien)

- tunica serosa (peritoneum)
- capsula (tunica fibrosa)
- facies
  - diaphragmatica
  - visceralis (renalis, gastrica, colica, pancreatica)
- extremitas anterior + posterior
- margo inferior + superior (obsolete “margo crenatus“)
- hilum splenicum (medially)
- sinus splenicus

© David Kachlík 30.9.2015
Spleen (splen, lien)

• length 10-13 cm; width 6-8 cm; thickness 4 cm
• weight depends on the blood filling
• ♂ 140-160 g / ♀ 120-150 g
• weight 200 g is not pathological
• lig. splenorenale, gastrosplenicum, splenocolicum, phrenicosplenicum
• splen accessorius (= spleniculus)
• 4-6 segments

© David Kachlík 30.9.2015
Spleen – position and syntopy

- intraperitoneal organ
- left hypochondrium
- 4 cm lateral to medioclavicular line
- 9th-11th rib, long axis along 10th rib
- normally not palpable
- bursa omentalis
- cavitas pleuralis

© David Kachlík 30.9.2015
Spleen – position and syntopy
Spleen – structure

• fibrous capsule (collagene)
  – sparse smooth muscle cells
  – covered with serosa (except hilum)
  – fibrous septa into pulp (*trabeculae splenicae*)

• pulpa splenica
  – pulpa alba
    • zona marginalis
    • noduli lymphoidei splenici
  – pulpa rubra
    • *Billroth‘s cords*

• reticular connective tissue

© David Kachlík 30.9.2015
Spleen - characteristic

- secondary lymphoid organ
- largest lymphoid organ
- immunologic blood filter
  - removal of microorganisms
- „cemetery“ of erythrocytes
- storage of blood
- hematopoiesis during development

© David Kachlík 30.9.2015
Spleen - HE (x 12)
Spleen – blood supply

• truncus coeliacus → a. splenica → rr. splenici → aa. trabeculares → arteriolae vaginatae pulpa albae
  – within periarterial lymphatic sheath (PALS; vagina lymphoidea periarteriolaris)
  – arteriolae centrales (nodulares) within noduli lymphoidei splenici
  – sinuses of zona marginalis

→ aa. pulpa rubrae → aa. penicillares → arteriolae penicillares
  → vagina perioarteriolaris macrophagocytica (Schweigger-Seidel’s caspule)

• vasa sinusoidea splenica (in pulpa rubra)
  – open x closed circulation
  – fusiform endothelial cells, clefts, interrupted basal lamina

→ vv. pulpa rubrae → vv. trabeculares → v. splenica → v. portae

© David Kachlík 30.9.2015
Spleen – white pulp

- reticular connective tissue with lymphocytes
- cords ensheath arteries – PALS (vagina lymphoidea periartriolearis)
  - T-lymphocytes
- arteries within nodules located excentriclly
- Malpighi‘s corpuscle
  - B-lymphocytes
- zona marginalis – between pulpa rubra/alba
  - sinuses and lymphoid tissue
  - macrophages (antigen presentation)
Spleen
white pulp

HE
(x 150)
Spleen – white pulp HE (x 225)

© David Kachlik 30.9.2015
Spleen – red pulp

- Billroth‘s cords (*chordae splenicae*)
  - cells between sinusoids
  - lymphocytes, macrophages, erythrocytes
  - reticular fibers (*fibrae reticulares anulares*) – hoop arrangement

- blood sinuses
  - fusiform endothelial cells (*endotheliocyti fusiformes*), interrupted (*endothelium disjunctum*)
  - located close to reticular fibers
  - spatium intersinusoides splenicum

© David Kachlík 30.9.2015
Spleen - PAS

© David Kachlik 30.9.2015
Spleen - histophysiology

- immune function of lymphocytes
- destruction of erythrocytes
Spleen – clinical relevance

- splenomegaly (viral mononucleosis, liver disease, blood cancers - lymphoma and leukemia)
- hypersplenism
- „two-stroke“ rupture of spleen
  - abdominal injury
- splenectomy
  - higher tendency to encapsulated bacteria
    *(pneumococcus, meningococcus, haemophilus)*
  - mandatory vaccination
- sickle-cell disease
- thrombocytopenia

© David Kachlík 30.9.2015
Spleen

- X-ray
- US
Splenomegalia
Spleen - development

- derived from mesenchyme of dorsal mesogastrium (*mesenchyma splanchnopleurale*)
- from 5th week
- mesenchymal cells – differentiation ⇒
  - capsule
  - reticular net
  - parenchyma
- 4th month - hematopoiesis
- from 2nd month - lymphopoiesis

© David Kachlík 30.9.2015
Spleen - development
Spleen – developmental disorders

- asplenia
- conjunction splenogonadalis, splenopancreaticca
- lobulatio splenis
- nodulus splenicus accessorius
- polysplenia
- splen accessorius (gl. suprarenalis, pancreas, gaster, intestinum) – 10 %
- splen migrans

© David Kachlík 30.9.2015
Splen accessorius 10%
Splen accessorius

1 – hilum splenicum
2 – pancreas (or its vicinity)
3 – lig. splenocolicum
4 – omentum majus
5 – mesenterium
6 – apertura pelvis superior
7 – ovarium/tuba uterina
8 – scrotum
9 – hiatus oesophageus diaphragmatis
10 – omentum minus