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PATHOLOGY OF MUSCULOSKELETAL SYSTEM

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PATHOLOGY OF MUSCLES

EQUINE RHABDOMYOLYSIS

It is also known as Azoturia or Monday Morning Disease. The disease occurs in well fed horse after a gap of holiday. Suddenly after walking few steps, the horse is unable to move further and feels pain with intense sweating and hardening of muscles.

Etiology
- Accumulation of lactic acid in muscles
- High glycogen storage
- Lack of oxygen supply

Macroscopic features
- Hardening of muscle just like wood
- Urine is dark brown with myoglobin-myoglobinuria
- Tonic spasms in muscles
- Atrophy of affected muscles in chronic cases

Microscopic features
- Necrosis of muscle fibers
- Oedema
- Hyaline degeneration (Fig. 13.1).
- Invasion of sarclemma by macrophages and lymphocytes
- Degeneration and necrosis of tubular epithelium in kidneys.

WHITE MUSCLE DISEASE

Extensive coagulative necrosis of muscles is observed in calves possibly due to deficiency of vitamin E during 6 month of age (Fig. 13.2).

Etiology
- Vitamin E deficiency
- Selenium deficiency
- Stress

Macroscopic features
- Colour of muscle becomes pale pink, yellowish red, grey or white (Fig. 13.3).
- Muscle becomes dry, inelastic and firm.
- Urine is brown/red or chocolate brown in colour because of myoglobin.

Microscopic features
- Coagulative necrosis of muscles.
- In some muscle cells, cloudy swelling can be observed.
- Neutrophils, macrophages, lymphocytes and eosinophils may present.
- Calcium may be deposited in necrosed areas.

ACUTE MYOSITIS

Acute myositis is the acute inflammation of skeletal muscles characterized by the presence of serous, fibrinous or haemorrhagic exudate (Fig. 13.4 & 13.5).

Etiology
- Trauma
- Vitamin E/Selenium deficiency
- Clostridium chauvoei, the cause of black leg in cattle

Macroscopic features
- Muscles become extremely moist.
- Colour becomes red, consistency is firm and tense.
- Swelling and accumulation of gas in muscles, crepitating sound on palpation.
- Muscle dark red/black with gas mixed exudate (Fig. 13.6 & 13.7).

Microscopic features
- Presence of serous, fibrinous and/or haemorrhagic exudate.
- Infiltration of neutrophils, macrophages, lymphocytes, etc.
- Degenerative and necrotic changes in muscles.
- Presence of Gram positive rods in exudate.

HAEMORRHAGIC MYOSITIS

Haemorrhagic myositis is characterized by the presence of large amount of blood and inflammation in muscles. It may occur due to trauma and muscle rupture (Fig. 13.8).

Etiology
- Trauma
- Clostridial infections
Fig. 13.1. Photomicrograph showing hyaline degeneration in muscle

Fig. 13.2. Photograph of white muscle disease (ARS/USDA)

Fig. 13.3. Photograph showing muscular dystrophy

Fig. 13.4. Photograph showing acute myositis

Fig. 13.5. Photomicrograph showing acute myositis due to clostridia

Fig. 13.6. Photograph showing gangrenous myositis in poultry

Fig. 13.7. Photograph showing gangrenous myositis in heifer

Fig. 13.8. Photograph showing haemorrhagic myositis
Macroscopic features
- Area becomes red/cyanotic.
- On cut, large amount of blood comes out from muscles.
- On touch, the affected area is hard and painful to touch.
- Regional lymphnodes may become enlarged and swollen.

Microscopic features
- Extravasation of blood in between the myofibrils.
- Infiltration of neutrophils, macrophages and lymphocytes in connective tissue between the muscle cells.

CHRONIC MYOSITIS
Chronic inflammation of muscle is characterized by necrosis, calcification and proliferation of fibrous connective tissue. In case of tuberculosis and pseudotuberculosis, there are multiple, focal nodules containing caseation and fibrous capsule.

Etiology
- *Mycobacterium tuberculosis*
- *Corynebacterium pseudotuberculosis*
- *Trichinella* spp. infection
- *Sarcosporidia* spp. infection

Macroscopic features
- Muscles become hard to touch.
- Nodules can be seen (Fig. 13.9).
- On cut the lesions of caseation and calcification observed.

Microscopic features
- Caseative necrosis, infiltration of macrophages, lymphocytes and proliferation of fibrous tissue.
- Calcification can also be observed.
- In cases of pseudotuberculosis infiltration of neutrophils is seen.
- Extensive infiltration of eosinophils in sarcosporidia infection.

PATHOLOGY OF BONES

FIBROUS OSTERODYSTROPHY
Fibrous osteodystrophy occurs as excessive action of parathyroid hormone on bones and characterized by bone resorption with replacement by fibrous tissue, increased osteoid formation which does not get sufficient minerals for deposition and formation of cysts.

Etiology
- Hyperparathyroidism
- Dietary deficiency of calcium or excess of phosphorus
- Vitamin-D deficiency
- Excessive bran feeding (Disease in horses of flour millers).

Macroscopic features
- Lack of calcification in bone
- Resorption of calcium from bone, fibrosis
- Bone becomes short, flexible and deformed
- Rubbery jaw due to involvement of facial bones

Microscopic features
- Fibrous tissue hyperplasia in bones.
- Enlargement of Haversian canals.
- Boney tissue is replaced by fibroblasts, with osteoclastic giant cells lining the remaining bone tissue.

RICKETS
Rickets is failure of adequate deposition of calcium in bones of growing animals caused by deficiency of calcium and vitamin-D and characterized by bending of limbs, enlargement of ends of long bones and skeletal deformities (Fig. 13.10).

Etiology
- Vitamin D deficiency
- Calcium deficiency
- Deficiency of phosphorus

Macroscopic features
- Bending of legs, bow legs
- Pot belly
Fig. 13.9. Photograph showing chronic myositis (ARS/USDA)

Fig. 13.10. Photograph of calf showing rickets

Fig. 13.11. Photograph showing osteomyelitis in mandible (Actinomyces) (ARS/USDA)

Fig. 13.12. Photograph showing fracture

Fig. 13.13. Photomicrograph of fracture healing

Fig. 13.14. Photograph showing spondylitis (ARS/USDA)

Fig. 13.15. Photomicrograph showing spondylitis (ARS/USDA)

Fig. 13.16. A. Photograph showing arthritis B. Diagram showing immune complex deposition in joint
- Enlarged costochondral articulation
- Softening of bones

**Microscopic features**
- Increase in proliferating cartilage adjacent to the area of ossification and its disorderly arrangement.
- Disorderly penetration of cartilage by blood vessels
- Increased area of uncalcified osteoid tissue
- Fibrosis of marrow

**OSTEOMALACIA**
Osteomalacia is also known as *adult rickets*. It occurs in bone of adults caused by deficiency of vitamin D and calcium and characterized by softening of bones.

**Etiology**
- Vitamin-D deficiency
- Calcium-phosphorus ratio disturbance

**Macroscopic features**
- Softening of bones
- Irregular diffuse thickening of bones
- Bone deformities

**Microscopic features**
- Increase in osteoid tissue with failure of calcification
- Increase in osteoclastic activity

**OSTEOPOROSIS**
Osteoporosis is atrophy of bones caused by possibly hormonal imbalance and characterized by inadequate deposition of calcium, brittleness of bones due to its increased porosity.

**Etiology**
- Hormonal imbalance
- Vitamin C deficiency
- Copper deficiency

**Macroscopic features**
- Inadequate calcium deposition
- Bone becomes brittle and porous
- Increased fragility of bones

**Microscopic features**
- Widening of Haversian canals
- Increased activity of osteoclasts
- Decrease in zona compacta and thickness of bone trabeculae

**OSTEOPETROSIS**
Osteopetrosis is enlargement of bone caused by fluorosis or avian leukosis virus and characterized by increase in bony tissue. It is also known as *marble bone disease*.

**Etiology**
- Avian leukosis virus of retroviridae family
- Fluorosis

**Macroscopic Features**
- Enlargement of bone towards outside and inside.
- Reduced marrow cavity
- Bone becomes brittle, marbelling of bones.

**Microscopic features**
- Cartilage is also calcified, surrounded by osteoid tissue.

**OSTEOMYELITIS**
Osteomyelitis is the inflammation of bone with bone marrow caused by trauma and pyogenic bacteria and characterized by destruction, replacement and excessive growth of new bone adjacent to the infected part (Fig. 13.11).

**Etiology**
- Hematogenous infection
- Direct infection through trauma/fracture
- *Actinomyces pyogenes, A. bovis*
- *Staphylococcus aureus*
- *Pseudomonas aeruginosa*

**Macroscopic features**
- Metastatic abscess in bone marrow
• Excessive growth of bone in adjacent area.
• Exostosis or endostosis.

Microscopic features
• Infiltration of neutrophils
• Proliferation of osteoid tissue
• Demonstration of bacteria in pus

BONE FRACTURE AND REPAIR
Fracture is the break in the continuity of bone due to trauma. A fracture may be simple or compound depending on the severity of trauma. Healing of fracture occurs by reunion of the broken ends of bone through development and proliferation of fibroblasts, angioblasts, osteoid tissue and infiltration of calcium salts (Fig. 13.12 & 13.13).

Etiology
• Trauma
• Accidents-automobile accidents.

Macroscopic features
• Fracture can be identified by break in bones.
• Healing of fracture is characterized by development of callus at the site of reunion of break ends of bone.
• Callus may be soft or hard.

Microscopic features
• Proliferation of fibroblasts, angioblasts and metaplasia of connective tissue to osteoid tissue.
• Areas of calcification in osteoid tissue

PULMONARY OSTEOarthropathy
Pulmonary osteoarthropathy is a rare disease of dog, sheep, cat, horse, and lion caused by prolonged anoxia and characterized by cough, dyspnea, respiratory disturbances and formation of new bone leading to thickening and deformity of limbs.

Etiology
• Prolonged anoxia
• Toxaemia

Macroscopic features
• Pneumonia
• New bone formation just beneath the periosteum in long bones.
• The proliferation of bone is irregular leading to rough surface.
• Bone becomes enlarged twice to its normal size.
• Heart worms in case of dogs.

Microscopic features
• Bronchogenic carcinoma
• Granulomatous lesions of tuberculosis
• Chronic bronchiectasis
• Hyperplasia of osteoid tissue with no indication of any kind of neoplastic growth in bones.

SPONDYLITIS
Spondylitis is the inflammation of vertebrae caused by bacteria/fungi and characterized by caseation, intraosseous abscess formation granulomatous lesions and fibrosis (Fig. 13.14 & 13.15).

Etiology
• Brucella abortus, Br. ovis, Br. meletensis
• Actinomyces bovis
• Coccidioidomyces sp.

Macroscopic features
• Intraosseous abscess
• Granuloma encapsulated by fibrous tissue involving one or two adjacent vertebrae.
• Local enlargement of bone.

Microscopic features
• Granulomatous lesions with caseation
• Proliferation of osteoid tissue
• Infiltration of neutrophils in intraosseous abscess.

PATHOLOGY OF JOINTS
ARTHITIS
Arthritis is the inflammation of joint caused by bacteria, virus, chlamydia, mycoplasma and
immune complexes and characterized by serus, fibrinous, purulent or ankylosing lesions in joints.

**Etiology**
- Bacteria- *E. coli, Erysipelas rhusiopathae, Streptococcus* sp., *Shigella* sp. *Corynebacterium ovis, Brucella* sp.
- Mycoplasma- *Mycoplasma mycoides, Mycoplasma sinoviae*
- Virus- Reovirus (Tenosynovitis in birds)
- Antigen antibody complexes
- Trauma

**Macroscopic features**
- Swelling of joints with increase in synovial fluid (Fig. 13.16).
- Difficulty in movement
- In chronic cases fusion of two bony processes leaving no joint (ankylosing)
- Synovial fluid diminishes, becomes dirty, thick in chronic illness

**Microscopic features**
- Presence of increased number of leucocytes in synovial fluid.
- Serus, fibrinous or purulent exudate in joints.
- Thickening of synovial membrane
- Presence of plasma cells and immune complexes in synovial fluid.

**MODEL QUESTIONS**

**Q. 1.** *Fill in the blanks with suitable word(s).*

1. Gas gangrene is produced by................. in thigh muscles of heifer which is manifested by................. sound on palpation due to accumulation of................. and.................
2. Equine rhabdomyolysis occurs in horses................. after a day rest and is characterized by................. and................. of muscles.
3. Osteomalacia is also known as................. which is caused by deficiency of................. and disturbances in ratio of................. characterized by.................
4. ................. and................. may led to osteoporosis in animals characterized by................. of bones.
5. Avian leucosis virus may cause................. in birds characterized by................. of bone.
6. Osteomyelitis is inflammation of................. and................. caused by................. and................. characterized by................. and................. of new bone adjacent to the infected part.
7. Healing fracture is characterized by the development of................. at the site of reunion of break ends of bone.
8. Arthritis is inflammation of................. characterized by................. of joints.

**Q. 2.** *Write true and false and correct the false statement.*

1. ......In white muscle disease the colour of urine becomes redish brown due to presence of haemoglobin.
2. ......Sarcosporidia causes eosinophilic myositis.
3. ......In rickets, the deficiency of calcium may lead to softening of bones
4. ......Osteopetrosis is enlargement of bones.
5. ......Osteoporosis is atrophy of bones.
6. ......Metastatic abscess are formed in bone marrow due to osteomyelitis.
7. ......Fracture is break in continuity of bones due to trauma.
8. Prolonged anoxia may lead to pulmonary osteoarthropathy in dogs.
9. Spondylitis is the inflammation of intervertebral disc.
10. Rheumatoid arthritis is caused by reovirus infection.

Q. 3. Define the followings.
1. Myoglobinurea
2. Millers disease
3. Osteitis
4. Osteomyelitis
5. Exostosis
6. Enostosis
7. Callous
8. Spondylitis
9. Tenosynovitis
10. Ankylosis

Q. 4. Write short notes on the followings.
1. Azoturia
2. Osteoporosis
3. Gas gangrene
4. Rickets
5. Arthritis
6. White muscle disease
7. Osteopetrosis
8. Fibrous osteodystrophy
9. Pulmonary osteoarthropathy
10. Fracture healing

Q. 5. Select most appropriate word(s) from the four options given against each statement.
1. Equine rhabdomyolysis is also known as ……….. morning disease
   (a) Sunday  (b) Monday  (c) Tuesday  (d) Wednesday
2. Accumulation of …………. is responsible for hardening of muscles in azoturia.
   (a) Lactic acid  (b) Myoglobin  (c) Haemoglobin  (d) Glycogen
3. White muscle disease is caused by …………. deficiency.
   (a) Vit-A  (b) Vit- D  (c) Vit-C  (d) Vit-E
4. Rickets is caused by deficiency of vitamin…………….
   (a) A  (b) D  (c) C  (d) E
5. Osteoporosis is caused by deficiency of …………. 
   (a) Copper  (b) Zinc  (c) Iron  (d) Calcium
6. Osteopetrosis is also known as ……………… disease 
   (a) Brittle bone  (b) Marble bone  (c) Both a & b  (d) None
7. Fibrous osteodystrophy is characterized by …………… condition
   (a) Lock jaw  (b) Rubbery jaw  (c) Bottle jaw  (d) None
8. Osteomyelitis is inflammation of ………….. 
   (a) Bone  (b) Bone marrow  (c) Both a & b  (d) None
9. Brucella sp may cause …………. in animals and man.
   (a) Pulmonary osteoarthropathy  (b) Spondylitis  (c) Rickets  (d) Osteopetrosis
10. Rheumatoid arthritis is caused by …………. 
    (a) Antigen-antibody complex  (b) E. coli  (c) Reovirus  (d) Brucella sp.