18

PATHOLOGY OF URINARY SYSTEM

- Developmental anomalies
- Functional disturbances
- Pathology of kidneys
  - Glomerulonephritis
  - Interstitial nephritis
  - Pyelonephritis
  - Nephrosclerosis
  - Urolithiasis
- Pathology of ureter
- Pathology of urinary bladder
  - Cystitis
- Pathology of urethra
  - Urethritis
- Model Questions
DEVELOPMENTAL ANOMALIES

Aplasia
Absence of one or both kidneys. Absence of one kidney is observed in animals with compensatory hypertrophy of another kidney and such animals may survive well.

Hypoplasia
The size of kidneys remain small which don’t grow properly due to defect in a single recessive autosomal gene.

Cyst in Kidney
Single or multiple cysts in pig and dog kidney are reported with tinged yellow in colour. They may arise from nephron due to its distension. Presence of multiple cysts is also termed as congenital polycystic kidney.

- **Type-I** cysts are formed due to dilation and hyperplasia of collecting tubules resulting in spongiform kidneys. In such neonates cystic bile ducts are also present.
- **Type-II** polycystic kidney is formed due to absence of collecting tubules and developmental failure of nephron. The cysts are thick walled with dense connective tissue and may involve one or both kidneys.
- **Type-III** cysts in kidneys occur due to multiple abnormalities during development. Cysts develop from tubules or Bowmen’s capsule with part of glomeruli in cyst. This condition is bilateral and causes considerable enlargement of kidney due to clear fluid or blood mixed fluid containing cysts.

FUNCTIONAL DISTURBANCES

Proteinuria
Presence of protein particularly albumin in urine. Protein is found as smooth, homogenous, pink staining precipitate also called as ‘cast’. The presence of albumin in urine is indicative of damage in glomeruli. It is also characterized by oedema due to protein deficiency.

Haematuria
Presence of blood in urine giving bright red colour. It may occur due to damage in glomeruli, tubule or haemorrhage anywhere from glomeruli to urethra. The most important cause of haematuria is bracken fern toxicity (Fig. 18.1).

Haemoglobinuria
When haemoglobin is present in urine without erythrocytes due to intravascular haemolysis. The urine becomes brownish red in colour. It must be differentiated from haematuria in which intact erythrocytes are present and settle down after some time leaving clear urine as supernatant. Haemoglobinuria is caused by various infections such as *Leptospira* sp., *Babesia* sp. or phosphorus deficiency in animals (Fig. 18.1).

Anuria
Absence of urine is known as anuria which may be due to:
- Absence of urinary secretion due to glomerulonephritis
- Inelastic renal capsule unable to exert sufficient pressure required for glomerular filtration leading to nephrosis.
- Due to Hydronephrosis or calculi urine already secreted puts back pressure to prevent further secretion.
- Low blood pressure
- Dehydration
- Necrosis of tubular epithelium

Polyuria
Increased amount of urine leading to frequent urination caused due to diabetes insipidus, hormonal imbalance and polydipsia. In this condition, waste products are successfully eliminated.

Uremia
The presence of harmful waste products like uric acid, creatinine and urea in blood. Normally such waste products are removed by excretion through kidneys. But due to damage in kidneys or obstruction by inflammation, neoplasm, abscess
Fig. 18.1. Photograph showing (A) Normal (B) haematuria and (C) haemoglobinuria

Fig. 18.2. Photograph showing nephrosis

Fig. 18.3. Photomicrograph showing nephrosis (coagulative necrosis)

Fig. 18.4. Photomicrograph showing nephrosis

Fig. 18.5. Diagram of immune complex mediated glomerulonephritis
and most importantly by presence of calculi urine remains in the system and causes uremia. Uremia is characterized by headache, vomiting, hyperirritability, convulsion, ulcers in oral cavity and stomach, normochromic and normocytic anemia, hemosiderosis and thrombocytopenia.

**Glycosuria**
Presence of glucose in urine. This is also known as diabetes mellitus, a metabolic disorder. It may occur due to insulin deficiency. This condition is not common in animals. However, it may occur in dogs as a result of hypoglycemia. It may occur in sheep due to enterotoxaemia caused by *Clostridium welchii* type D.

**Pyuria**
Presence of pus in urine due to suppurative inflammation in urinary tract.

**Ketonuria**
Presence of ketone bodies in urine, which is common in diabetes mellitus, acetonemia, pregnancy toxaemia and in starvation.

**Oliguria**
In this condition, there is decreased amount of urine, which occurs due to glomerulonephritis, obstruction in urinary passage, dehydration, low blood pressure and tubular damage.

**NEPHROSIS**
Nephrosis is the degeneration and necrosis of tubular epithelium without producing inflammatory reaction. It mostly includes acute tubular necrosis as a result of ischemia or toxic injury to kidney. Nephrosis is characterized by necrosis and sloughing of tubular epithelial cells exhibited by uremia, oligouria, anuria (Fig. 18.2 to 18.4).

**Etiology**
- Hypotension
- Heavy metals
- Mycotoxins *e.g.* Ochratoxin
- Antibiotics *e.g.* Gentamicin

**Macroscopic features**
- Swelling of kidneys
- Capsular surface smooth, pale and translucent.

**Microscopic features**
- Vacuolation in tubular epithelium.
- Coagulative necrosis.
- Sloughing of tubular epithelium

**GLOMERULONEPHRITIS**
Glomerulonephritis is the inflammation of glomeruli primarily characterized by pale and enlarged kidneys with potential haemorrhage, oedema of glomeruli, congestion and infiltration of inflammatory cells. Due to presence of mesangial proliferation, it is also called as mesangio proliferative glomerulonephritis (MPGN) (Fig. 18.5 to 18.7).

**Etiology**
- Streptococci infection
- Immune complexes
- Environmental pollutants such as - Organochlorine pesticides

**Macroscopic features**
- Enlarged kidneys
- Oedema, pale kidneys
- Petechiae on kidneys
- Proteinuria, uremia, hypercholesterolemia and increased creatinine level in blood.

**Microscopic features**
- Oedema of glomeruli leading to increase in size.
- Infiltration of neutrophils, macrophages.
- Compression of blood capillaries and absence of erythrocytes.
- Thrombosis and necrosis of glomerular capillaries.
- Based on type of lesions, it can be divided into 5 subtypes.

1. **Type-I MPGN**
- Proliferation of mesangial cells.
Fig. 18.6. Diagram showing different locations of deposits of immune complexes A. subendothelial, B. Membranous and C. Sub epithelial deposits of immune complexes.

Fig. 18.7. Photomicrograph showing immune complexes in glomeruli (Immunoperoxidase staining)

Fig. 18.8. Photomicrograph showing interstitial nephritis

Fig. 18.9. Photomicrograph showing interstitial nephritis with severe haemorrhages in interstitium.

Fig. 18.10. Photomicrograph showing suppurative nephritis

Fig. 18.11. Photomicrograph of kidney showing nephrosclerosis

Fig. 18.12. Photograph of kidney showing nephrolithiasis

Fig. 18.13. Photograph of kidney showing nephrolithiasis
INTERSTITIAL NEPHRITIS

Interstitial nephritis is the inflammation of kidney characterized by degeneration and necrosis of tubular epithelium, oedema and infiltration of inflammatory cells in interstitium (Fig. 18.8 & 18.9).

**Etiology**
- Ochratoxins and atrinin.
- Leptospira
- Toxins/ poisons e.g. Pesticides.
- Herpes virus
- Endogenous toxemia e.g. Ketosis
- Immune complexes

**Macroscopic features**
- Enlargement of kidneys
- Necrosis, congestion and haemorrhage

**Microscopic features**
- Oedema, congestion, haemorrhage
- Necrosis and degeneration of tubular epithelium
- Infiltration of inflammatory cells like neutrophils, macrophages and lymphocytes in interstitium.
- Loss of tubules, foci of mononuclear cells, fibrosis in chronic cases
- Immune complexes are deposited in granular form causing degeneration of epithelial cells of tubules and mononuclear cell infiltration.

PYELONEPHRITIS

Pyelonephritis is the inflammation of renal pelvis and parenchyma i.e. tubules characterized by congestion, suppurrative inflammation and fibrosis.

**Etiology**
- Corynebacterium renale
- Staphylococcus aureus
- E. coli
- Actinomyces pyogenes
- Pseudomonas aeruginosa
Macroscopic features
- Congestion, haemorrhage and abscess formation in renal cortex, pelvis and ureters.
- Pyuria - Pus mixed urine in bladder.
- Enlargement of kidneys

Microscopic features
- Congestion, haemorrhage
- Suppurative inflammation of pelvis and kidney parenchyma (Fig. 18.10).
- Necrosis of collecting ducts.
- Purulent exudate in pelvis.
- Infiltration of neutrophils, lymphocytes and plasma cells in interstitium.

NEPHROSCLEROSIS
Nephrosclerosis is chronic fibrosis of kidney characterized by loss of glomeruli and tubules and extensive fibrosis (Fig. 18.11).

Etiology
- Glomerulonephritis
- Interstitial nephritis
- Arteriolosclerosis

Macroscopic Features
- Hard, atrophied kidneys.
- Fibrous nodules on kidneys.
- Thickening of capsule.
- Small white firm kidneys.

Microscopic features
- Ischemia, tubular atrophy
- Loss of glomeruli and tubules
- Extensive fibrosis
- Deposition of hyaline mass
- Infiltration of mononuclear cells.
UROLITHIASIS

Urolithiasis is the formation of stony precipitates anywhere in the urinary passage including kidneys, ureter, urinary bladder or urethra.

**Etiology**
- Bacterial infections
- Metabolic defects
- Vitamin A deficiency
- Hyperparathyroidism
- Mineral imbalance

**Macroscopic features**
- Nephrosis, Hydronephrosis
- Distension of ureters
- Distension of ureters and urinary bladder
- Hard enlarged kidneys
- Presence of calculi/stone in kidney, ureter, bladder or urethra (Fig. 18.12 & 18.14).
- There are various types of calculi, which differ in size, shape and composition. Some of them are as under:

**Oxalate calculi** are hard, light yellow, covered with sharp spines found in urinary bladder and formed due to calcium oxalate. It causes damage in urinary bladder leading to haemorrhage.

**Uric acid calculi** are composed of ammonium and sodium urates and uric acids, yellow to brown in colour, formed in acidic urine, spherical and irregular in shape and they are not radioopaque.

**Phosphate calculi** are white or grey in colour, chalky in consistency, soft, friable and can be crushed with mild pressure. They are mostly multiple in the form of sand like granules. They are composed of magnesium ammonium phosphate and occur as a result of bacterial infection.

**Xanthine calculi** are brownish red, concentrically laminated, fragile and irregular in shape. They rarely occur in animals.

**Cystine calculi** are small, soft with shiny and greasy in appearance, yellow in colour which becomes darker on air exposure. Insoluble amino acid cystine precipitates in bladder to form calculi. Such calculi may cause obstruction of urethra with cystinuria.

**Microscopic features**
- Presence of crystals/stone in lumen of tubules.
- Degeneration and necrosis of tubular epithelium.
- Haemorrhage
- Proliferation of fibrous tissue

**PATHOLOGY OF URETER**

**URETERITIS**

Ureteritis is the inflammation of ureter characterized by enlargement, thickening of wall due to accumulation of urates, or calculi, pyonephrosis and pyelonephritis (Fig. 18.15).

**Etiology**
- Tuberculosis
- Calculi
- Hydronephrosis
- Pyelonephritis
- Pyonephrosis

**Macroscopic features**
- Deposits of whitish/yellowish urates in ureter in poultry.
- Obstructions of ureter due to calculi leads to its enlargement and formation of diverticulum.

**Microscopic features**
- Thickening of the wall due to congestion and infiltration of inflammatory cells.
- Extensive fibrosis with infiltration of mononuclear cells in chronic cases.

**PATHOLOGY OF URINARY BLADDER**

**CYSTITIS**

Cystitis is the inflammation of urinary bladder characterized by congestion and fibrinous, purulent or haemorrhagic exudate (Fig. 18.16).

**Etiology**
- Urinary calculi
- Tuberculosis
- Blockage in urethra
- Bracken fern poisoning
Macroscopic features
- Congestion, haemorrhage.
- Enlargement of urinary bladder.
- Thickening of the wall.
- Presence of small nodules on wall.

Microscopic features
- Congestion, haemorrhage.
- Thickening of wall due to infiltration of neutrophils and macrophages.
- Granuloma in tuberculosis.
- Fibrosis
- Presence of neoplasm.

PATHOLOGY OF URETHRA

URETHRITIS
Inflammation of urethra is known as urethritis, which occurs as a result of catheter injury and calculi. It is characterized by congestion, obstruction, hydronephrosis and strictures (Fig. 18.17).

Etiology
- Calculi
- Catheter injury
- Trichomonas foetus infection
- Picorna virus infection

Macroscopic features
- Transient inflammation, congestion and haemorrhage.
- Strictures (male), diverticulum (female)
- Obstruction due to calculi, presence of calculi

Microscopic features
- Thickening due to inflammatory exudate.

MODEL QUESTIONS

Q. 1. Fill in the blanks with suitable word(s).
1. Increased amount of urine leading to……….urination is known as ……….which is caused by ………., ……….and ………. to remove the ……….at a faster rate.
2. Uremia is presence of ……….like ………., ……….and ……….in blood.
3. Presence of ketones bodies in urine has been observed in………., ………., ……….and ………
4. ………..are fungal toxins which may causes interstitial nephritis.
5. Environmental pollutants such as ……….may induce the formation of ……….in body leading to ……….in animals characterized by proteinuria.
6. Pyelonephritis is caused by ………., ………., ………., ……….and ……….; of which ……….is the main etiological agent causing disease in cattle.
7. Nephrosclerosis is ……….of kidney characterized by ………., ……….and ……….and mostly occurs as a sequaeaeae to ………., ……….and ……….

Q.2. Write true or false against each statement and correct the false statement.
1. ……….Glycosuria occurs in enterotoxaemia in sheep.
2. ……….Arteriosclerosis may lead to pyelonephritis.
3. ……….In cattle, Corynebacterium ovis causes pyelonephritis.
4. ……….Oxalate calculi are hard and composed of diammonium and sodium oxalates.
5. ……….Urolithiasis is presence of foreign body in kidneys.
6. ……….In poultry, ureteritis is common feature of visceral gout.
7. ……….Urinary calculi may cause urethritis in bullocks.
8. ……….Low blood pressure may cause polyuria
9. ……….Epithelial crescent is feature of interstitial nephritis.
10. ……….Hypovitaminosis A may predispose the animal for calculi formation in urinary tract.
Q. 3. Define the followings.
1. Haematuria
2. Pyuria
3. Cystitis
4. Anuria
5. Haemoglobinuria
6. Polyuria
7. Ketonuria
8. Oliguria
9. Epithelial crescents
10. Bracken fern toxicity

Q. 4. Write short notes on.
1. Uremia
2. Glomerulonephritis
3. Pyelonephritis
4. Nephrosclerosis
5. Urolithiasis
6. Cystic kidney

Q. 5. Select most appropriate word(s) from the four options given against each statement.
1. C₃ component of complement is found in which type of glomerulonephritis (MPGN).
   (a) Type-I (b) Type-II (c) Type III (d) Type-IV
2. In cattle, pyelonephritis is caused by ……….
   (a) E. coli (b) Proteus spp. (c) Corynebacterium renale (d) Actinomyces pyogenes
3. Nephrosclerosis is …………. disease of kidney
   (a) Acute (b) Chronic (c) Subacute (d) Peracute
4. Hypovitaminosis ………….may cause urolithiasis
   (a) A (b) B (c) C (d) D
5. Ureteritis is the inflammation of ………
   (a) Uterus (b) Uterine glands (c) Ureter (d) Uterine tube
6. …………. amino acid forms calculi in animal which causes obstruction in urethra.
   (a) Arginine (b) Lucine (c) Cystine (d) Gsolucine
7. Bracken fern causes ………
   (a) Haematuria (b) Pyuria (c) Haemoglobinuria (d) Anuria
8. Urethra may become infected by ………….virus.
   (a) Picorna (b) Picobirna (c) Birna (d) Adeno
9. Hyperplasia of collecting tubes with their dilation causes ………….cysts in kidneys.
   (a) Type-I (b) Type-II (c) Type-III (d) Type-IV
10. Uremia is caused by the increased level of ……………. in blood.
   (a) Urea (b) Uric acid (c) Creatinine (d) All of the above