Lectures of Human Embryology

Rectum, Anal canal, Urinary bladder & Urethra

By

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Development of Rectum and Anal Canal

1. The caudal end of hindgut dilates to form the cloaca. The cloaca is connected to the allantois (urachus) ventrally. It is closed caudally by cloacal membrane that represents the opposed layers of ectoderm and endoderm.

2. The mesoderm at the angle between the allantois and the hindgut proliferates and invaginates the endoderm of the cloaca forming a septum, called urorectal septum.

3. The septum extends caudally to divide the cloaca into:
   i. Primitive urogenital sinus ventrally &
   ii. Anorectal canal dorsally.

4. Further extension of the urorectal septum caudally divides the cloacal membrane into 2 parts;
   - anterior part called urogenital membrane &
   - posterior part called anal membrane.
   Also, it raises the ectoderm between the previous membranes to form the perineal body.

5. Further proliferation of the mesenchyme around the anal membrane creates an ectodermal depression around it, called proctodeum.

6. Anorectal canal forms the mucosa of rectum and upper part of anal canal (endodermal in origin). The lower part of anal canal is formed from the proctodeum (ectodermal depression roofed by anal membrane).

7. The anal membrane ruptures (at the 7th week of development) so that the 2 parts of anal canal become continuous together.

8. Mesenchyme surrounding the anorectal canal forms the musculature of rectum and anal canal.

Blood supply of anal canal reflects its double origin, as follows:
* The upper part of anal canal that is endodermal in origin, being derived from the endoderm of hindgut, is supplied by superior rectal artery which is the continuation of inferior mesenteric artery (artery of hindgut).
* However, the lower part of anal canal that is ectodermal in origin, being derived from the proctodeum (ectodermal depression roofed by anal membrane), is supplied by inferior rectal arteries which are branches of internal pudendal arteries.

* The line of fusion of the endodermal and ectodermal parts of anal canal is marked by a line called *pectinate line* that lies below the anal columns. This line marks the transition of anal canal lining from simple columnar to stratified squamous epithelium.

*N.B.: Middle rectal arteries supply mainly the musculature of the rectum and anal canal.*

**Development of anorectal canal**

**Congenital Anomalies of Rectum and Anal Canal:**

1. **Imperforate anus**: It is caused by failure of rupture of the anal membrane (i.e. failure of communication of the endodermal and ectodermal portions of anal canal).

2. **Rectal fistulae**: may be found:
   - Between the rectum and urethra (*recto-urethral fistula*),
   - Between the rectum and urinary bladder (*recto-vesical fistula*)
   - Between the rectum and vagina (*recto-vaginal fistula*).

   Cause is imperfect development of cloaca and/or urorectal septum. It is commonly associated with imperforate anus.

3. **Rectoanal atresia**: It is caused by failure of recanalization or defective blood supply of the developing part.

4. **Anal stenosis**: It is narrowing of the anus, resulting in difficulty to pass stool.

5. **Persistent cloaca**: It is caused by complete failure of development of the urorectal septum. It is more frequently occurring in females than males where the urinary bladder, vagina and rectum open in one cavity.
Development of Urinary Bladder

1. The cloaca is divided by the urorectal septum into 2 parts:
   - Anterior or ventral part, called primitive urogenital sinus.
   - Posterior or dorsal part, called anorectal canal.
2. The primitive urogenital sinus is divided by the attachment of mesonephric ducts into 2 parts:
   - Superior or cranial part, called vesico-urethral canal.
   - Inferior or caudal part, called definitive urogenital sinus.
3. The proximal portions of the 2 mesonephric ducts, till the openings of ureteric buds are absorbed into the posterior wall of vesico-urethral canal. Therefore, 4 separate openings (2 for mesonephric ducts and 2 ureteric buds) appear in the posterior wall of the bladder.
4. The 4 openings are at first close together. With ascent of kidneys, the openings of ureteric buds are pulled upwards and laterally. At the same time, the 2 mesonephric openings move close together to open into the upper (prostatic) part of urethra (forming the 2 ejaculatory ducts). The part of posterior wall bounded by the 4 openings forms the trigone of the urinary bladder.
5. **Then, the urinary bladder is formed from the following parts:**
   i. **Vesico-urethral canal:** It dilates to form most of the bladder.
   ii. **Urachus:** Its proximal part forms the apex of the bladder. The other part obliterates to form median umbilical ligament, connecting the apex of the bladder with umbilicus.
   iii. **Mesonephric ducts:** Their proximal portions (parts extending to origin of ureteric buds) are absorbed into the posterior wall of
bladder to form the trigone of the bladder (mesodermal in origin).

iv. The surrounding mesoderm form the muscles and connective tissue of urinary bladder.

*N.B.: Most of the bladder is endodermal in origin, except the trigone which is mesodermal in origin.*

6. **The urethra is formed from the following parts:**

   **A. Male urethra:**
   1. The upper part of prostatic urethra (till the openings of ejaculatory ducts) develops from the vesico-urethral canal (endodermal in origin).
   2. The rest of urethra (lower part of prostatic urethra, membranous part and penile part, except the part in glans) develops from the definitive urogenital sinus (endodermal in origin).
   3. Terminal part of penile urethra (part in glans penis): develops from solid ectodermal cord that becomes canalized and communicates with other penile part.

   **B. Female urethra:**
   1. The upper large (4/5th) part: develops from the vesico-urethral canal (endodermal in origin).
   2. The lower small (1/5th) part: develops from the definitive urogenital sinus (endodermal in origin).

The muscles and connective tissues of the urethra develop from the surrounding mesoderm.

*N.B.: Prostate gland* arises as a number of endodermal outgrowths from the prostatic (upper part of) urethra. In females, the urethral and paraurethral glands arise from the cranial part of urethra.
Congenital Anomalies of Urinary Bladder:

1. Urachal fistula:
   It is caused by failure of obliteration of the whole intra-embryonic part of allantois (urachus).
   It is often presented clinically with drainage of urine through the umbilicus.

2. Urachal cyst:
   It is caused by failure of obliteration of middle portion of allantois (urachus).
   This portion dilates to form a cyst due to accumulation of secretion of its lining mucosa.

3. Urachal sinus:
   It is caused by failure of obliteration of upper portion of allantois (urachus).
   It may leads to mucous discharge at the umbilicus.

4. Recto-vesical fistula (fistula between urinary bladder and rectum):
   It is caused by imperfect development of urorectal septum leading to incomplete separation between the vesico-urethral canal and anorectal canal.

5. Ectopia vesicae (or extrophy of urinary bladder):
   The posterior wall of the bladder appears through a gap in the anterior abdominal wall.
It is caused by failure of development of the infra-umbilical part of mesoderm forming the musculature of the anterior abdominal wall and anterior wall of the balder. This is followed by rupture of the thin surface ectoderm (of skin) and the underlying endoderm (mucosa of bladder). This case is commonly associated with epispadias. It presents clinically with urine drainage to the exterior. Surgical repair is difficult and prolonged.

*Congenital anomalies of urinary bladder:* Anomalies of urachus (A), Anomalies due to defects in urorectal septum (B), Anomalies of mesoderm in-front of bladder (C).

**Congenital Anomalies of Urethra:** are mentioned with anomalies of external genitalia.