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"BLADDER DUPLICATION" EMBRYOLOGICAL BASIS AND ITS CLINICAL IMPORTANCE

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ABSTRACT

Normally, humans have only one urinary bladder but it's not so in the case of bladder duplication because more than one bladder is present in this case and it occurs as a result of an abnormal development of the body specifically the abnormal development of the urinary system during the fourth week of embryological development. Bladder duplication was classified by Abrahamson into two forms based on the degree of duplication; complete and incomplete bladder duplication. And also, it can be classified into sagittal or coronal duplication based on the position of the accessory bladder in relation to the normal bladder.

Introduction

Urinary system is one of the important systems of the body. It helps in maintaining homeostasis in the body or blood by osmoregulation. It helps in maintaining constant osmotic pressure in the body by the control of blood and salt concentrations. It is a group of organs in the body apprehensive with filtering out surplus or excess fluid and other substances in form of urine (a liquid produced by the kidneys, collected in the bladder and excreted in the course of the urethra.) from the bloodstream. The urinary system has couples of organs that makes it up and helps it to carry out its excretory functions. These organs include two kidneys, two ureters, a urinary bladder and the urethra. They all work together or function in one way or the other to get rid of wastes and excess water from the body system. For this article, I will be focusing more on the urinary bladder also simply called bladder. The urinary Bladder functions in receiving urine from the kidney and storing it up until its disposal during urination which is simply the release of urine from the urinary bladder through the urethra. The bladder is a hollow muscular organ and it can hold up to two cups of urine for about two to five hours comfortably. Normally, humans have only one urinary bladder but it's not so in the case of bladder duplication because more than one bladder is present in this case and it occurs as a result of an abnormal development of the body specifically the abnormal development of the urinary system during the fourth week of embryological development.

However, this anomaly, bladder duplication, was classified by Abrahamson into two forms based on the degree of duplication; complete and incomplete bladder duplication [1]. And also, it can be classified into sagittal or coronal duplication based on the position of the accessory bladder in relation to the normal bladder. These two classifications will be discussed later in the course of this article. Bladder duplication is an unusual or rare congenital anomaly and it's often associated with other anomalies especially in the case of complete bladder duplication. Such associated anomalies include duplication of the lower gastrointestinal part, external genitalia, spina bifida and meningocele or myelomeningocele.

Incidence

Even the bladder duplication is a rare anomaly, complete bladder duplication is the most common type having 50 cases been reported while incomplete bladder duplication is less common with the report of only 10 cases [2]. In the other way round, bladder duplication on the sagittal plane is more common than the coronal plane bladder duplication with a ratio of 2.5:1 in reported cases.

Ontogenesis of normal urinary bladder development

Starting from the basis, the hindgut is the posterior or caudal part of the embryonic alimentary canal from which the colon and rectum develop. The terminal part of the hindgut ends in the cloaca. The cloaca is an endoderm-lined chamber which connects to the surface of ectoderm at the cloaca membrane and also communicates with the allantois, which is a membranous sac that prolongs into the umbilicus together with the vitelline duct. Cloaca is divided into dorsal or inferior portion and ventral or superior portion by the urorectal septum. The dorsal portion develops into the rectum and anal canal while the ventral portion develops into the bladder and urogenital sinus which will later give rise to the bladder and lower urogenital tracts [3].The urogenital sinus is divided into three parts; a vesicle part, a pelvic part, and a phallic part.

The vesicle part forms most of the urinary bladder and is constant or continues with the allantois. In the neck of the bladder, the pelvic part forms or develops into the urethra (prostatic part of the urethra in males and complete urethra in the females). Lastly, the phallic part grows towards the genital tubercle primordium of the penis or of the clitoris.

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The vesicle part of the urogenital sinus gives rise to the urinary bladder but the triangular area of the bladder or the bladder's trigone which is at the base of the bladder between the openings of the ureters is derived from the caudal ends of the mesonephric ducts.

The endoderm of the vesicle part of the urogenital sinus gives rise to the whole epithelium of the bladder whereas other layers of the bladder wall develop from adjacent splanchnic mesenchyme. At first, the bladder lingers with the allantois but later on the allantois narrows and becomes a thick fibrous cord called the urachus. The urachus in adults is signified by the median umbilical ligament and it prolongs from the peak of the bladder to the umbilicus.

Furthermore, the distal parts of the mesonephric ducts are incorporated into its dorsal wall as the bladder expands or enlarges. In the trigone of the bladder, mesonephric ducts also give to the development of the connective tissue. Ureters open discretely into the urinary bladder as the mesonephric ducts are absorbed.

The orifices or openings of the ureters are not left out; they move superolaterally and enter indirectly or obliquely through the base of the bladder due to the adhesion applied by the kidneys as they ascend.

The openings of the mesonephric ducts move close together in case of males and cover the prostatic part of the urethra as the caudal ends of these ducts develop into the ejaculatory ducts while in the case of females, the distal ends of the mesonephric ducts generate.

The Abrahamson's classification, as mentioned earlier in the introduction, he classified bladder duplication into two which are; complete and incomplete bladder duplication. Though the embryological basis for these types of duplication is unknown, some explanations and theories have been given as a supposed cause.

Firstly, complete bladder duplication is termed as complete when two bladders are completely separated by the mucosal and muscular layers that comprise the septum and drain into separate urethras while incomplete bladder duplication is defined as an incomplete separation of two urinary bladders by a septum that drains into a single urethra.

According to the Abrahamson's explanation [7], complete bladder duplication occurs when there is extreme contraction between the urogenital and vesicourethral portions of the ventral cloaca, and also as a result of supernumerary cloaca septum that depresses the epithelial wall of the bladder.

In the other way round for incomplete bladder duplication, it occurs when there is partial contraction or constriction between the urogenital and vesicourethral portions of the ventral cloaca.

In the case of classifications of urinary bladder duplication based on the planes, we have coronal and sagittal plane urinary bladder duplication of which sagittal plane duplication is more common. In the sagittal plane duplication, two urinary bladders lie sideways and are separated by a fold of peritoneum and loose areolar tissue. Each urinary bladder receives the ureter of the ipsilateral kidney and is drained by its own urethra with the ureter and urethra lying side by side.

While in coronal plane urinary bladder duplication which is less often, the additional bladder usually lies anterior and superior on the normal bladder.

Discussion

Bladder duplication like other congenital anomalies is also associated with other anomalies especially in the case of complete bladder duplication. Such associated anomalies include bladder septation, duplication of the lower gastrointestinal part, external genitalia, spina bifida and meningocele or myelomeningocele [4].

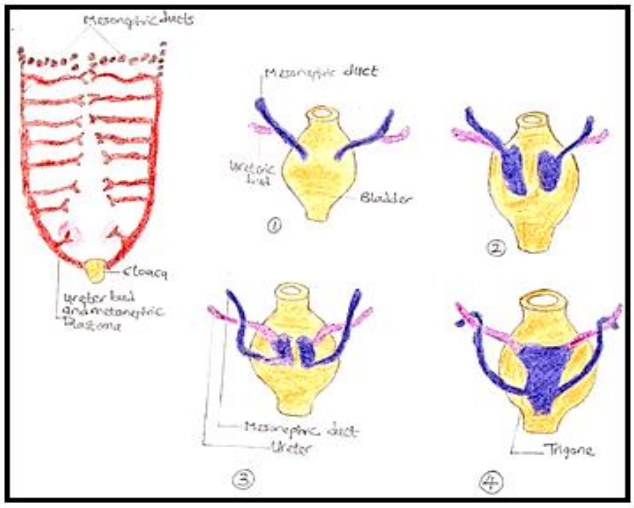

Fig 1. Development of urinary bladder Ontogenesis for urinary bladder duplication.

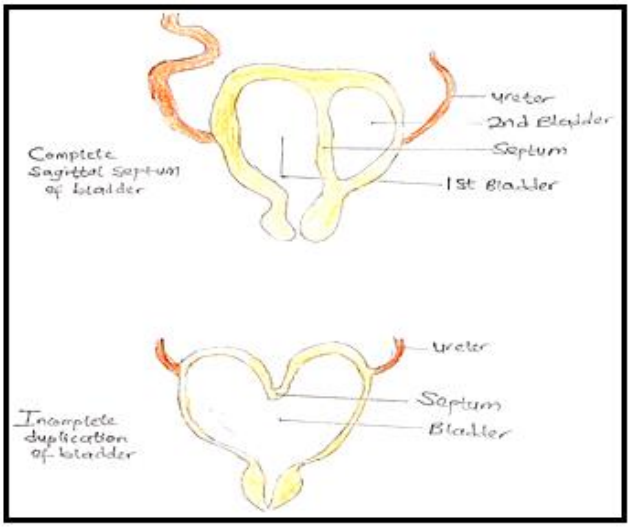

Fig 2. Complete sagittal septum of bladder and incomplete duplication of bladder.

Bladder septation is very similar to bladder duplication. It has the same classifications as bladder duplication that is, complete and incomplete bladder septation (depending on how far the wall extends toward the bladder neck) and coronal or sagittal septation (depending on the plane of its occurrence).

In bladder septation, a fibro-muscular wall gulfs the bladder into distinct sections. In contrast to bladder duplication, bladder septation creates two compartments that share a common wall. Bladder septation is not related with duplication of the urethra so; both compartments are in open communication with the urethra.

Another associated anomaly is the duplication of the gastrointestinal part. Gastrointestinal duplication is also a rare congenital anomaly which includes cervical duplications (duplications of the esophagus), thoracic and thoracoabdominal duplications, gastric duplications, duodenal duplications, other small intestine duplications, colonic duplications and rectal duplications. Duplication of any of the gastrointestinal part can lead to the duplication of the urinary bladder so as to meet the functional requirements of these systems.

Duplication of the external genitalia is another anomaly associated with bladder duplication. The external genitalia is found in females. It's the additional structures of the female

reproductive system that are outside to the vagina. They are also denoted as the vulva or pudendum.

The external genitalia comprises the labia majora, mons pubis, labia minora, clitoris, and glands within the vestibule.

Duplication of the bladder can result in duplication of the urethra which can result in the duplication of the external genitalia. In this case, the female patient will have two different urethral opening for the passage of urine.

While in meningocele, only the meninges thrust out of the opening in the spine.

Other associated anomalies are fistulas between the rectum, vagina, and urethra.The fistula is an abnormal linking between two tubes or between a tube and a surface. When there is abnormal linking of urethra and vagina it is called urethrovaginal fistula while abnormal linking between the rectum and the vaginal is referred to as rectovaginal fistula. These fistulas are associated with bladder duplication in such a way that when there is duplication in the bladder especially with a duplicated urethra but not duplicated external genitalia or duplicated penis in case of a male, the additional urethra might open or connect into another organ such as the rectum or even the colon.

Urinary bladder duplication can be diagnosed before and after birth. Before birth, a medical ultrasound or sonography which is a diagnostic imaging technique that is used to see internal body structures or internal organs can be used to check for any duplication in the fetus. This is possible when the mother goes for a scanning or antenatal care. That is the reason why every pregnant woman is advised to go for antenatal care so that the growth, development, and health of both the mother and child can be monitored.

While after birth, diagnosis demands the examination of all orifices to determine the anatomic relationship and the functional possibilities.

Treatment for duplication of the bladder may be compound because of the associated anomalies and is usually restricted to procedures for maintaining normal function. Early treatment is engaged at assuring that there is no obstruction or infection.

Complete bladder duplication has a much higher occurrence of associated anomalies demanding surgical correction, such as fistulas among the urethra and nearby structures. The variable anatomy of each case determines the surgical method that will be used. A joint robotic-open method was described by Bowen et al in a patient with bladder duplication and urethral triplication [6]. The main purpose of the surgery is to make corrections in the affected organs.

Urinary bladder duplication can be lifesaving if proper treatment is given early to prevent infections. Surgery might also be needed based on the situation especially for fistulas so as to save the patient from further infections that might claim the life of the patient.

Conclusion

In conclusion, complete and incomplete bladder duplication can both occur in planes that are, the coronal and the sagittal plane. So, we can have separate bladders in such that the additional one is sideways with the normal one (which is complete bladder duplication on sagittal pane) or separate bladders with the additional one on top or superior to the normal one (complete bladder duplication on the coronal plane. This is very rare). Also, on the other hand, there can be incomplete sagittal (sideways) or incomplete coronal (superior and anterior) urinary bladder duplication.

Apart from the associated congenital anomalies with urinary bladder duplication, we also have associated skeletal anomalies which are diastasis of the symphysis pubis, complete duplication of the lower lumbar vertebral column, spina bifida, and meningocele [4].

Urinary bladder duplication can be treated and also it can be surgically corrected especially in the case of the presence of fistulas. Nevertheless, the precise and early diagnosis of urinary bladder duplication and its associated anomalies will be of great help to the survival of the patient.

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