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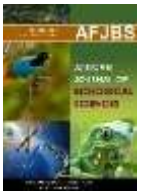

Anatomical and developmental variations of upper urinary tract in central part of Tamil Nadu: Cadaveric pilot study

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Abstract:

Background: Congenital abnormalities in the upper urinary tract impact 20-30% of prenatal cases and range from mild alterations to illnesses requiring kidney transplantation. An awareness of these variances is critical for surgical success and patient outcomes.

Aim: The purpose of this study was to thoroughly analyze and describe the anatomical variations of the upper urinary tract, with an emphasis on the kidneys and ureters, in cadavers from the central region of Tamil Nadu, India.

Methodology: Thirty-five cadavers (10 adult and 25 perinatal) were dissected at K.A.P.V Government Medical College in Tiruchirappalli. The study's goal was to describe the morphology, location, and length of ureters using traditional dissection procedures. Specimens were thoroughly inspected for anomalies such as duplication, incorrect placement, and associated renal anomalies. The ureteric length from the renal hilum to the bladder was recorded.

Results: Adult cadaver specimens had varying ureteric lengths (12-18 cm on the right and 12.6-17.5 cm on the left), with abnormalities occurring in 12% of cases, including twin ureters and nonexistent kidneys. Perinatal specimens indicated developmental differences such as convoluted courses (20% of fetuses) and anomalies such as missing kidneys (one instance) and duplicate ureters (two cases). Cystic kidneys and polycystic kidney disease were among the associated kidney malformations seen in both adult and perinatal populations.

Conclusion: This study emphasizes the value of detailed anatomical information in detecting and treating congenital urinary system abnormalities. The findings indicate considerable differences in ureteric morphology and related kidney anomalies, which are critical for improving surgical outcomes and patient care. More research is needed to extend awareness, particularly in different groups, which will benefit in developing better management solutions for these tough illnesses.

Keywords:

Upper urinary tract, Cadaveric study, Anatomical variations, Ureter, Kidney anomalies, Congenital anomalies, Surgical planning

Introduction

Congenital anomalies in upper urinary tract (especially in kidney and ureter) comprise a wide spectrum of disorders ranging from simple to end stage renal disease. Anatomical knowledge of ureter is very important for urologist and renal transplant surgeon. Failure to recognize anatomical variations will cause significant morbidity and mortality. In the prenatal period, congenital anomalies of kidney and urinary tract constitute approximately 20 to 30% of all anomalies identified. [1] Congenital or developmental anomalies of the ureter anomalies may be unilateral or bilateral. Variations may occur either in number (single/double/triple) or in position of the ureter (normal/retrocaval), or in the diameter –megaureter, or in opening into bladder (normal/ectopic). Surgeons reported difficulties due to distorted anatomy in upto 25.8% of cases of ureteric injury. [2] Common surgeries associated with ureter injuries are hysterectomy (54%), colorectal surgery (14%), and abdominal vascular surgery (6%). Renal agenesis is yet another vital disordercommonly seenin males with an incidence of approximately 1 in 1000 births (unilateral) and 1 or 2 in 10000 (Bilateral). Polycystic kidney disease is characterized by the growth of numerous cysts in the kidney. It accounts for 8-10% of all cases of end stage renal disease. Simple cysts are present in 5% of general population which comprised 25-33% of >50 years of age. Duplication of ureter represents a significant proportion of anomalies of urinary tract. Incidence of duplicated ureter may ranges from 0.5% to 3% with female predominance.[3] If duplication of ureter is associated with aberrant/accessory renal arteries, it forms one of the common differential diagnoses for ureteric calculi and recurrent urinary tract infections. Duplication of ureter is also associated with other anomlies ofkidney, renal vessels, and urinary bladder.[4] Incomplete duplication is three times more common than complete duplication. To summarize, both radiologists and surgeons must have a thorough understanding of the normal and atypical ureter patterns before planning any surgical surgery. There is a shortage of information on the duplex system and double ureter in the Indian populace. Cadaveric studies are still significant and useful in the present era of imaging methods. The study's aims were to investigate the morphology and anatomical variances of the ureter, as well as to observe the accompanying kidney defects.

Materials & Methods

A total of thirty-five cadavers (adults=10 and perinatal =25) were used for this study and the dissection protocol was carried out in Department of Anatomy, K.A.P.V Government medical college,Tiruchirappalli, Tamilnadu. Specimens obtained from adult cadavers were given to undergraduate students andfetal cadavers over 12 weeks of age were examined. Seventy

specimens were collected by conventional dissection method. The morphology, position and length of ureter (by measuring tape) were observed.

The ureters were approached after removing the abdominal viscera. The peritoneum from posterior abdominal wall was removed to expose the abdominal part of the ureter. Similarly,pelvic viscera and pelvic peritoneum from the posterior wall was removed to expose the course of ureter. Its arrangement at the renal hilum,and its course in the abdomen and pelvis was noted. Ureters relations to the surrounding structures were studied. Anomalies of ureter and kidney and ureter if present also noted. The length of ureter positioned in abdomen and in pelvis was measured. Length of the ureter was measured from its formation to its opening into the urinary bladder wall. The dissected specimens were numbered serially and photographed. Readings obtained were recorded and tabulated. [5]

Dissection of the fetus

The external examination of the fetus includes weighing and measuring offetus. Crown rump (CRL) was measuredusing measuring tape. The body was placed on a block to raise the shoulders and chest, above the dissecting surface. The neck was hyper extended anda Y-shaped incision wasmade as arms of the Y extended to the top of the shoulders to free up the skin over the anterior aspect of the neck. The arms of the Y extend around the lateral aspects and just inferior to the nipples to meet inferiorly in the midline at the xiphoid process. A vertical incision was made in the midline from the xiphoid process to the symphysis pubis. The midline incision extends around the left side of the umbilicus. A small nick was made near the umbilical vein and the abdominal cavity was opened up by scissors.

Lifting upward on the abdominal wall would eliminate cutting into the abdominal organs. One finger was inserted inferior to the umbilicus and along the inner abdominal wall to palpate the umbilical arteries, which extend on either side of the urinary bladder. An ellipse made around the right side of the umbilicus to preserve the urachus, umbilical arteries and umbilical vein. The skin and subcutaneous tissues were dissected away from the anterior–lateral aspects of the lower ribs, exposing the abdominal organs. All the abdominal organs were removed for exposure of the posterior abdominal wall. The peritoneum from posterior abdominal wall was removed to expose the abdominal part of the ureter. During this course, pelvic viscera werealso removed. Course, relations, anomalies of the ureter, associated kidney anomalies also noted in a similar manner as in adult cadavers. [6]

Results and Discussion

The ureter was studied in 70 specimens taken from 10 adult and 25 fetal human cadavers (Figure 1) and was preserved in formalin. In adult specimens the first length varies from 12 to 18 cm on right side, on left side 12.6 to 17.5cm. Second length is measured from bifurcation of common iliac artery upto the base of the bladder which ranges from 9 to 14 cm on right side, on left side it is 11 to 14 cm. In fetuses of 12- 20 wks ureter length measures about 1.7cm-5.6cm. In fetuses of 20- 30 wks ureter length measures about 3.8 cm-8.1cm. Costello et al., in 2004 did a study in 15 cadavers. [7] Mean length of ureter in adults was 24.16 -26.33 cm. Out of 50 foetal specimens, ureter is absent in one specimen.

Figure 1: Dissected Fetuses

Course of the Ureter

In 20 specimens of adult cadavers, ureter has a normal course. In the 25 fetuses, 5 fetuses have a tortuous course. Of the ureter in 2 fetuses of 20 wks gestation, the tortuous course is found in both right and left sides. One fetus of 20 wks has a tortuous course on left side. One fetus of 20 wks has a dilated tortuous course on left side, absent kidney and ureter on right side. One fetus of 28 wks has a tortuous course on left side with double ureter on right side, remaining one fetus of 32 wks has a tortuous course only on left side.

Hilar Structure Relations

In 20 adult specimens, variation seen in both right and left side offive specimens that belonged to same cadaver. Remaining 3 specimens have variation in the hilar structures on right side. In all these abnormal specimens, hilar structure arrangement is from anterior to posterior are renal artery, renal vein, and renal pelvis. Commonly,there are no variations in the relations of inferior vena cava with ureter and ureter with the aorta in both adult and fetal specimens. However, 25% of cases of variations in hilar structures which shows the arrangement of renal artery, renal vein and renal pelvis from anterior to posterior aspect were observed. The observed variations were greater (21.8%) and five type of hilar patterns were previously documented.

Anomalies of Ureter

In 20 adult specimens there are no anomalies in the ureter. In 25 fetuses ureter anomalies are found in 3 fetuses. Double ureter is found in 2 fetuses of which one is in 14 wksfetus on left side (Figure 2). Another double ureter is in 28 wksfetus on right side. In one fetus it is absent on right side which is 20 wks of gestation. The presence of double ureter increases the possibility of ureteral injury during surgery and misinterpretation of radiological images. It is important to have knowledge about the hilar structures since it is helpful in nephrons sparing surgeries like partial nephrectomy. Absent ureter on right side is accompanied by absent kidney on right side and dilated tortuous ureter on left side with cystic kidney left side (Figure 3). The present study reported ureter anomalies in 12% of 70 specimens. In recent studies, the specimens showed an incomplete double ureter were between 6 and 8%. [8, 9]

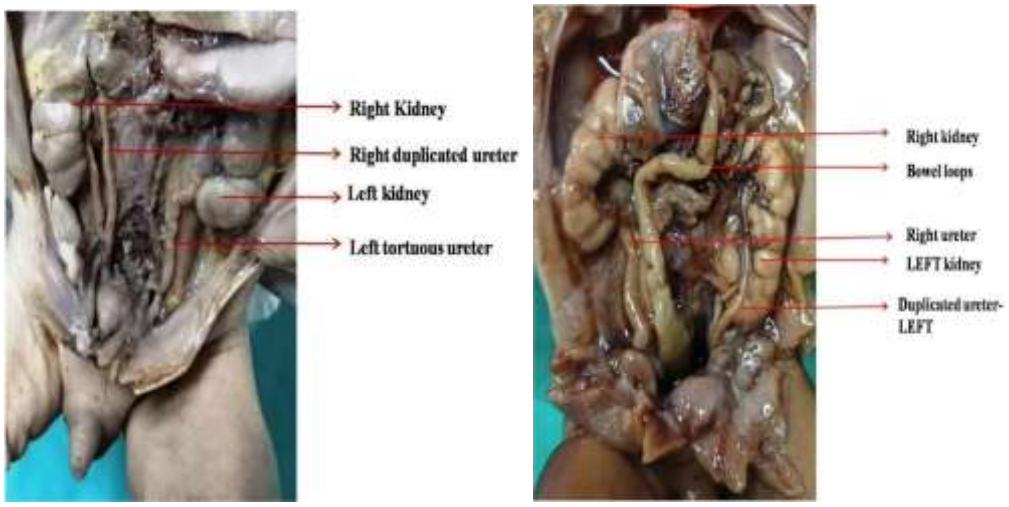

Figure 2: Duplicated Ureter

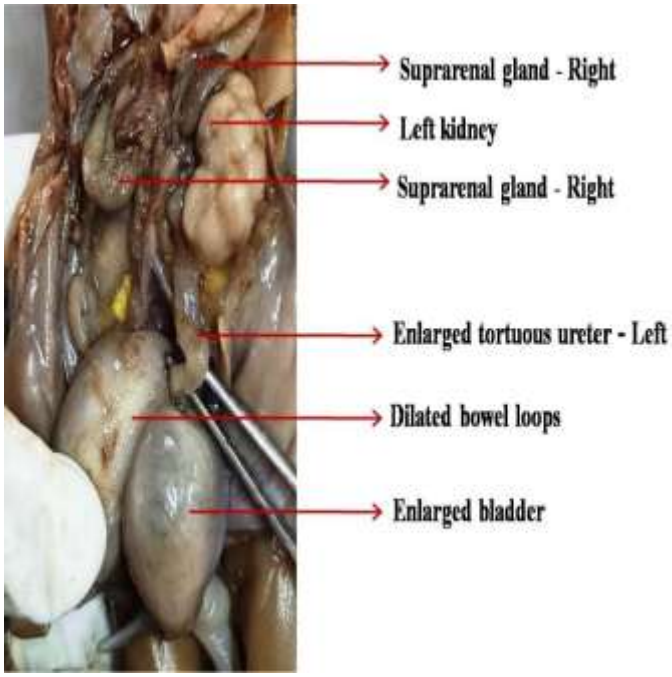

Figure 3: Variations in Ureter

Associated Kidney Anomalies

In adult cadavers, there are renal cysts are present in the two kidney specimens. In 25 fetuses renal anomalies are found in 3 fetuses. One fetus of 14 wks has a mega cystic kidney on both sides accompanied by dilated ureter on right side and double ureter on left side (Figure 4). Second fetus of 20 wks has multiple cortical cysts on both kidneys. Third fetus of 20 wks has a cystic kidney with dilated tortuous ureter on left side. On right side both kidney and ureter are absent. This study showcased 9% and 10% of kidney anomalies in adult and fetal specimens respectively. Earlier reports on renal anomalies among 320 fetuses of 12 to 35 weeks were 17.6%. [10] Among 48 human cadavers, bilateral polycystic kidneys were present in 4% of cases. [11]

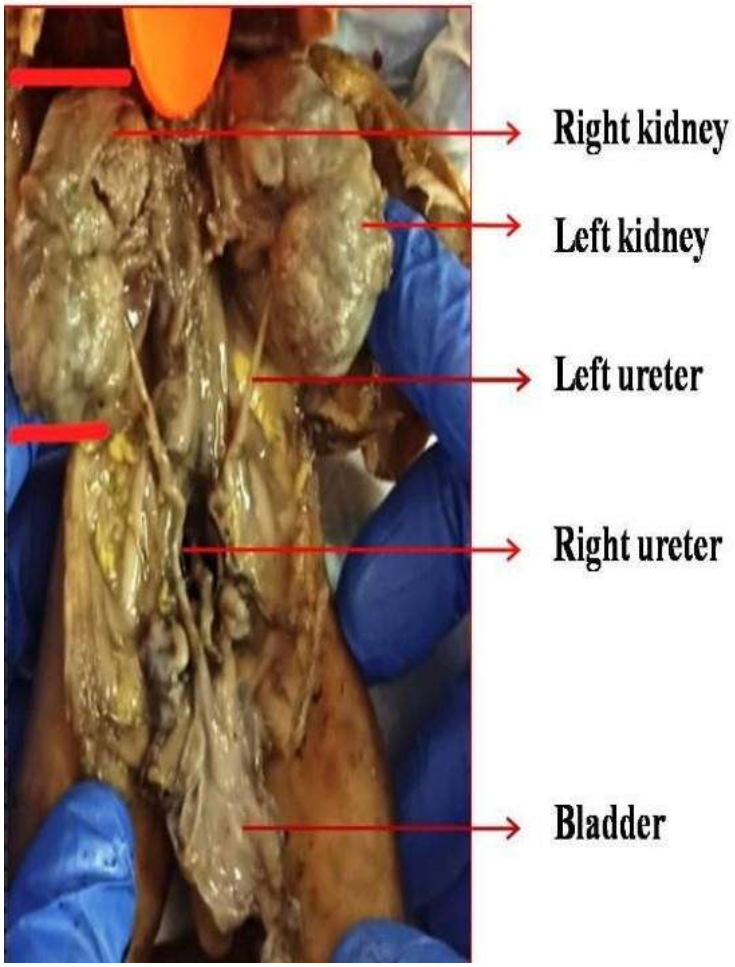

Figure 4: Fetus with Bilateral Enlarged Cystic Kidneys

Conclusion:

This cadaveric pilot study sheds light on the anatomical and developmental differences of the upper urinary tract in central Tamil Nadu, India. The study found significant variation in the anatomy, location, and length of the ureter between adult and perinatal cadaver specimens. Anomalies such as duplicate ureters, tortuous courses, and missing kidneys were discovered, emphasizing the therapeutic importance of detailed anatomical knowledge for surgical planning and therapy of congenital urinary tract anomalies. The discovery of related kidney anomalies, such as cystic kidneys and polycystic kidney disease, highlights the complexities of these illnesses and the importance of accurate pre-operative examination. These findings are critical for improving surgical results, minimizing complications, and providing better patient care. Moving forward, more research in varied populations is needed to better understand the incidence and features of these anatomical abnormalities. Such initiatives will help to improve clinical methods and therapies for those who have upper urinary tract congenital abnormalities.

Conflict of interest

The authors declare no conflict of interest.

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