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ORIGINAL RESEARCH

Unilateral incomplete duplication of ureter with complete duplicated pelvicalyceal system violating Weigert- Meyer Law and Stephens ectopic pathway- A cadaveric Study

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ABSTRACT

Introduction: Duplication of ureter is one of the most common anomalies of the urinary tract. Duplication may be either complete or incomplete. The incidence of duplex renal collecting system and ureter ranges from 0.5%- 3%. Clinically, it may remain asymptomatic, it may cause repeated urinary tract infection (UTIs) or calculi, also get injured during pelvic surgeries. **Materials and Methods:** A total of 48 kidneys and ureter specimens were carefully dissected following the guidelines outlined by Cunningham's Manual of Practical Anatomy, at the dissection hall of the World College of Medical Sciences and Research and Hospital, Jhajjar, Haryana. The specimens were examined for presence and types of double ureter and duplex pelvicalyceal system. **Results:** Out of 48 kidneys, one (2%) specimen showed unilateral duplicated left ureter arising from upper and lower pole of duplex renal pelvis that cross each other and then join together to form a single ureter (y-shape) distally before opening into urinary bladder. **Conclusion:** Awareness of embryological development, the types and varieties of double ureter will aid radiologists and surgeons to interpret and diagnose urological images and preventing accidental injury to ureter while performing surgeries.

Keywords: Duplex renal collecting system, repeated UTIs, calculi.

INTRODUCTION

The ureters are two muscular tubes which drain urine from the kidneys to the urinary bladder. Each ureter measures around 25–30 cm in length, is thick-walled with narrow lumina, and is continuous superiorly with the funnel-shaped renal pelvis. The ureters pierce the posterior aspect of the bladder and run obliquely through its wall for a distance of 1.5–2.0 cm before terminating at the ureteric orifices. Intramural ureters are occluded at the time of micturition due to increase in bladder pressure which prevents reflux of urine into ureter. [1]

Duplication of ureter is one of the most common anomalies of the urinary tract. Duplication may be either complete, incomplete, unilateral or bilateral. [2]

In incomplete or partial duplication of ureter, two ureters arising from renal pelvis of one kidney drain into the urinary bladder by a single common ureter.While in case of complete ureteral duplication, double ureters drain separately into the urinary bladder or one ureter opens into the bladder and another opens into genital tracts such as the vagina, the urethra, or the vulval vestibule (vestibulum vagina). [3-5]

The Weigert-Meyer law states that 'In a complete ureteral duplication, the ureter whose orifice is more medial and caudal reaches the upper moiety and the other ureter whose orifice is more lateral and cephalad reaches the lower renal moiety.' [6]

In a Duplicated collecting system, there are two separated pelvicalyceal systems which drain single

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renal parenchyma into urinary bladder via incomplete or complete ureteral duplication. [3-5]

The incidence of duplex renal collecting system and ureter ranges from 0.5%- 3% [7]. Occurrence of incomplete duplication is 3 times more than complete [2].

Embryologically, early divisions of ureteric bud before penetrating the metanephric tissue give rise to bifurcated renal pelvis with incomplete duplication of ureter. [3,8]

A complete duplication of ureter occurs if two separate ureteric buds arise from the mesonephric duct on one side of the embryonic body. As a result, metanephric tissue may be divided into two parts, each with its own renal pelvis and ureter. [3-5]

Clinically, it may remain asymptomatic, may cause repeated urinary tract infection (UTIs) or calculi, also get injured during pelvic surgeries. The most common complication during open or laparoscopic surgical procedures involving the abdomen and pelvic region is ureteral injury. [9]

MATERIALS AND METHODS

The study was conducted at the dissection hall of the World College of Medical Sciences and Research and Hospital, Jhajjar, Haryana. Kidneys with ureters and bladder were dissected and removed from cadavers of 24 North Indian individuals of either sex, following the guidelines outlined by Cunningham's Manual of Practical Anatomy [10]. The kidneys, along with the ureters and bladder, were washed thoroughly in running water after removal and were stored in 10% formalin. Morphologically damaged kidneys were excluded from the study. The pelvicalyceal system of kidney with double ureter was observed by cutting along its lateral border. The findings were described and photographed.

RESULTS

Upon examination of 48 kidneys, 47 (98%) had a normal single ureter arising from the renal pelvis and opening into the urinary bladder. The remaining 1 (2%) specimen showed variation in ureter and renal pelvis.

In that specimen, unilateral duplicated left ureter was found. [Figure 1 and 2]

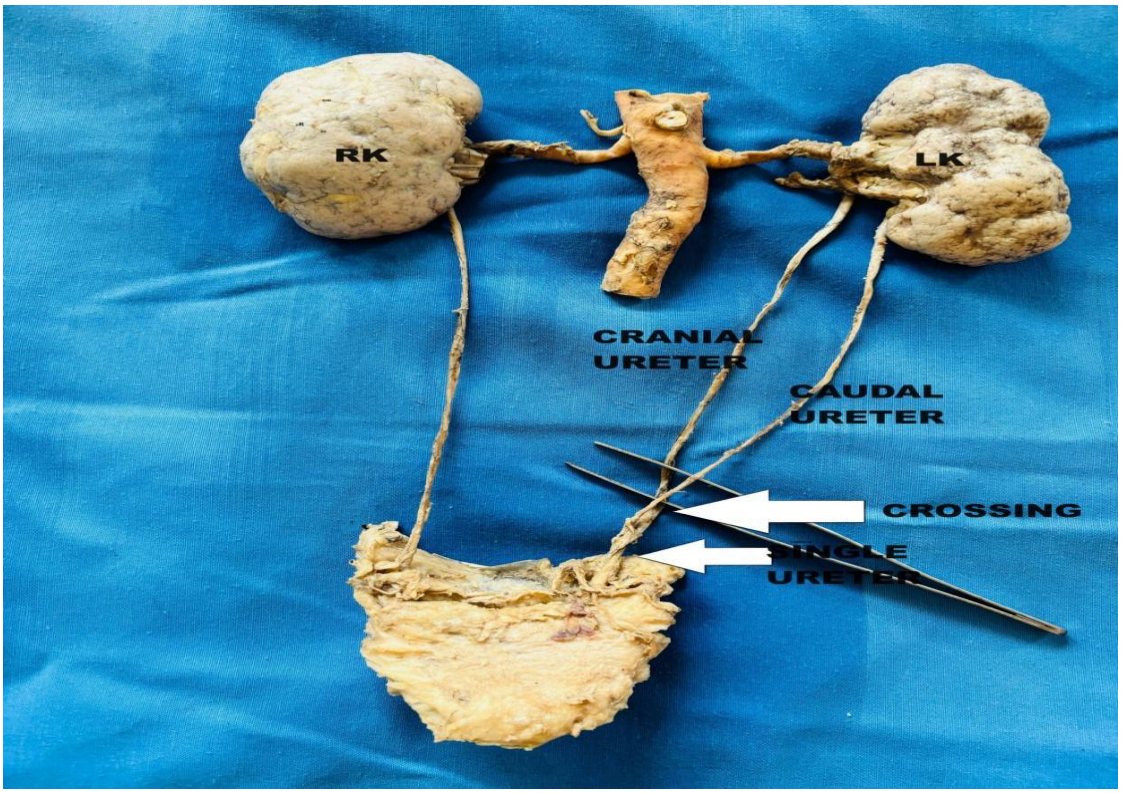

Figure 1 showing left kidney with an incomplete double ureter and crossing of both ureter

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Figure 2 showing Bifid 'Y' shaped ureter

Figure 3 showing duplicated renal pelvis of left kidney

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Ureter arising from upper pole of renal pelvis of left kidney (cranial ureter) and ureter arising from lower pole of renal pelvis of left kidney (caudal ureter) joined each other to form a single ureter (y-shape) distally before opening into urinary bladder. The length of stem of 'Y' shaped ureter is relatively very small in comparison to length of limbs of 'Y'.
Caudal ureter crossed cranial ureter before joining together.
Left Kidney appeared to be lobulated.
The left kidney had two separate renal pelves, each having its own ureter. [Figure 3]

DISCUSSION

The urinary system develops from two sources: metanephric blastema and mesonephric duct. Ureteric bud arises as a diverticulum from the caudal end of the mesonephric duct. This diverticulum elongates and later fuses with the metanephric blastema to form renal pelvis, which further divides into major and minor calyces. [11,12]
Double ureter occurs because of the abnormalities in the branching pattern of the ureteric bud. In the case of complete duplication, two ureteral buds arise, which form double ureter with two separate openings into the urinary bladder. [3]
In rare cases, one of the ureters can open into sites other than the urinary bladder, such as the vagina, seminal vesicle, urethra, prostate, epididymis, or vas deferens. This condition is called ectopic ureter. Incomplete duplication is due to splitting of the ureteric bud anywhere along its course to its termination into the metanephric blastema. The duplicated ureters unite at a variable distance away from the kidney, and only one ureteric orifice is seen in the bladder on that side. If the ureteric bud bifurcates after fusing with metanephric tissue, it results in a double pelvis and double ureter. [13]
Roy et al. found double ureters in 0.64% out of 156 kidney specimens [14].
Deka and Saikia reported left side incomplete duplication of ureter in 1 out of 60 specimens with an incidence of 1.67%.[15]
Prakash et al. did radiological and cadaveric study in 50 pairs of kidneys specimens and reported that incomplete duplication was more common than complete duplication [16]
Arumugam et al found in their study that out of 50 kidney and ureter specimens, 6% specimens showed incomplete double ureter with fusion at different levels to form single ureter opening into the urinary bladder. [9]
Choudhary et al. studied 32 specimens, of which two (6.25%) kidneys showed unilateral incomplete duplication. [17]
Dähnert studied excretory urograms and reported that incomplete duplication of the ureter was three-fold more common than complete duplication. [18]
According to Siomou et al., double ureters are commonly found on one side. [13]
In this study, we observed an incomplete double ureter on left side in one kidney (2%) out of 48 specimens.
The incidence of incomplete double ureter reported by various authors is shown in tabulated form. (table 1)

Table 1: Incidence of incomplete double ureter reported by various authors

Authors	Incomplete double ureter/total specimens	% of incidence
Roy et al [14]	1/156	0.64
Deka and Saikia [15]	1/60	1.67
Prakash et al [16]	2/50	4
Arumugam et al [9]	3/50	6
Choudhary et al [10]	2/32	6.25
Present study	1/48	2

In cases of incomplete bifid ureter, the union can occur at the vesicoureteric junction ('V' shape) or midway of its path ('Y' shape). [19] In the present study, the union occurs midway near vesicoureteric junction where stem of 'Y' is relatively very small in length in comparison to length of limbs of 'Y'.
In complete ureteric duplication, Weigert -Meyer rule (W-M rule) states that caudal and cranial ureter cross each other; caudal ureter opens into urinary bladder while cranial ureter can open at different sites. [20]
In the present study a rare finding was discovered that the two renal pelves of left kidney were separate and the duplicated ureter crosses each other which is same as in a usual case of complete duplication of ureter by W-M rule but we found that they join distally forming single ureter before opening into bladder i.e. incomplete duplication of ureter; therefore, breaking Weigert- Meyer rule.
Rarely reported in the literature, "ectopic pathway" of Stephens postulates that an ectopic ureter may drain not only distally to the normal ureteric orifice (Weigert-Meyer law) but may drain medially and superiorly to it (violating Weigert-Meyer law).[21]
In our study finding, Stephens ectopic pathway is also not followed since both the ureters of left kidney have joined before entering into urinary bladder.
Along the length of the normal ureter, there are three constrictions that predispose the ureter to stagnation of urine flow and occlude the passage of renal calculi. [1] The angled point of union of the two ureters in case of an incomplete double ureter creates a fourth constriction that can further obstruct normal flow, leading to reverse urine flow and associated complications such as hydronephrosis. One of the most common complications associated with double ureter is reflux.[22] Various studies have reported that

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patients with an incomplete double ureter are more prone to ureteroureteric reflux, whereas a complete double ureter is usually associated with vesicoureteric reflux. Urinary tract infection and obstructive uropathy are also associated with double ureter.[23, 24]

Ureteric injuries are a potential complication of any open or laparoscopic surgical procedure involving the abdomen and pelvis.[25]

In a duplex kidney drained by double ureter, the lower pole system is dominant in majority of the individuals; and hence the lower moiety is more frequently affected in pelvic-ureteric junction obstruction as compared to the upper moiety. [26]

A duplex kidney with ureterocele can be associated with vesicoureteral reflux in the lower pole of the duplex system.[27] Ureteropelvic junction obstruction can be associated with anomalies of the renal system.[28] Vesicoureteral obstruction reflux involving the lower pole in a duplex system usually results from maldevelopment of the valve mechanisms. On the other hand, stenosis of the upper pole ureteral orifice results in hydronephrosis involving the upper pole of the duplex system.[29]

CONCLUSION

Awareness of embryological development, types and varieties of double ureter aids radiologists and surgeons to interpret and diagnose urological images, thus preventing accidental injury to ureter while performing surgeries. The angled point of union of two ureters creates 4th constriction that can obstruct normal flow, leading to reverse urine flow and associated complications such as hydronephrosis.

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