

ANATOMICAL AND DEVELOPMENTAL VARIATIONS OF URETER IN NORTH-EAST POPULATION OF INDIA: A CADAVERIC STUDY

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ABSTRACT:

Introduction: The ureters are 2 muscular tubes whose peristaltic contractions convey urine from the kidney to the urinary bladder. Normal length of ureter proper is 25–30 cm and diameter of ureter is 3 mm in adult (males). Congenital /developmental anomalies or variations of ureter are common. May be unilateral or bilateral, usually asymptomatic. Becomes symptomatic when any pathology occurs at that site as they are common site for obstruction and infection. Variations occur in number (single/double/triple), position (normal/retrocaval), diameter -megaureter when diameter is >7mm according to Hellstrom M, >5mm according to Cussen, 1971, in opening into bladder (normal/ectopic).

Material & method: The study was conducted on 15 adult and 65 perinatal cadavers (>32 weeks of gestation) in Department of Anatomy during the years 2013-2015. Manual dissection was done in 10% formalin fixed bodies and measurements were taken by the help of measuring tape and vernier calliper.

Results: In present study 98.12% specimens showed normal morphology of ureter and 1.88% showed anomaly/developmental variation of ureter. Incidence of unilateral complete double ureter, bifid ureter and megaureter were found to be 0.62%, 0.62% & 1.25% respectively in present study. Incidence of anomalies was found to be more in females than males. In adult length of ureter is 23-28.5 cm and diameter is 2.4-3.6 mm. In perinates (>32 weeks) ureter length is 5-7.8 cm, diameter 2-4.6 mm.

Conclusion: From the present study we come to the conclusion that the ureter exhibits a wide spectrum of developmental variations. Review of the literature emphasizes this finding very well. Knowledge of these variations may be of some help not only for Anatomists, but also for the Urologists and Radiologists in application of various interventions.

Keywords: Length and diameter of ureter, Double ureter, Megaureter, variations, congenital anomaly



INTRODUCTION:

The ureters are 2 muscular tubes whose peristaltic contractions convey urine from the kidney to the urinary bladder. Length of ureter proper is 25–30 cm. Diameter of ureter is 3 mm. (Stranding S et al)

Congenital anomalies or variations of ureter are common. May be unilateral or bilateral, usually asymptomatic. Becomes symptomatic when any pathology occurs at that site as they are common site for obstruction and infection. Among these variations

duplication is common. It may be unilateral or bilateral (1 in 800), incomplete or complete. Duplication of ureter associated with duplication of renal pelvis (1 in 125 individual). In case of complete double ureters two ureters may empty separately into the bladder. In incomplete or bifid variety ureters fuse to form a single ureteral orifice. In incomplete group bifurcation may be present at any point in the course of the ureter, from the renal pelvis up to just above the bladder (Stranding S *et al*, 2008). According to recent studies of Russel *et al* (2000) on an average, 3% excretory urograms show ureteral duplication on routine examination. Incidence is as high as 8% in children being evaluated for UTI. Incomplete ureteral duplication is observed in approximately 1 in 25 individuals. Complete duplication is present in approximately 1 in 125 individuals. Complete duplication on one side results in a 40% chance of a complete duplication abnormality on the other side. (Christopher S Cooper). The upper pole ureter drains the upper pole of a duplex kidney while the lower pole ureter drains the lower pole (Weigert-Meyer Rule, 2010). Unilateral ureteral duplication is 6 times more common than bilateral duplication and has no clear sex preponderance or laterality preference. (Noah). Clinically, the incidence of the Y variant is lower than 0.9%, as this duplication is often without consequence. (Schenkman). Bifid ureter is reported to be twice more common in females and in right side (Rege *et al*).

Retro-caval ureter another anomaly where right ureter passes behind the inferior vena cava instead of laying to right of it (1 in 1500 individuals according to Heslin *et al*)^[1-10]

Ectopic ureter is one of congenital anomaly where ureter opens into other sites than usual site (bladder base). It is more commonly occurs in case of longer ureter of a duplex system, can insert more caudally and medially than normal. In male ureter can insert at the bladder neck or posterior urethra, or rarely into seminal vesicle. In female, ectopic insertion can be distal to external urethral sphincter in the urethra, or into vagina, resulting in persistent childhood incontinence.

Congenital megaureter

means the congenital dilatation of the ureter, may be associated with the dilatation of the renal pelvis where diameter of the ureter is greater than 5mm (Cussen L J, 1967 described that in children, any ureter greater than 7 mm in diameter is considered a megaureter based on measurements in fetuses greater than 30 weeks gestation and children <12 years.) and more than 7mm according to Hellstrom M *et al*. Megaureter may be primary or secondary, refluxing or nonrefluxing, obstructed or nonobstructed, and nonrefluxing unobstructed (Shokeir AA). Primary megaureter is an inherently compound term that includes all cases of megaureter due to an idiopathic congenital alteration at the vesicoureteral junction. Secondary megaureter occurs as a result of some abnormality involving the bladder or urethra (eg, urethral valves, neuropathic bladder dysfunction, urethral strictures, ureterocele, acquired causes of obstruction).

A complete and clear picture of morphology and variation of the ureter has got important value to the radiologists, nephrologists and surgeons of urology for proper interventions like percutaneous nephrolithotomy, ureteral stenting and interventional radiology. As

variations are very common site for pathology like calculi, inflammation, vesico-ureteral reflux, carcinoma etc. all of which invariably require surgical or nonsurgical interventions. Proper knowledge of the anatomy and their variations are necessary because operative procedures can be influenced by these variations. Improper knowledge of anatomy may lead to injury of the collecting system. Many studies regarding the anatomy of the ureter have been carried out earlier. However, these studies need to be revised from time to time to keep update with the change of this aspect. However, not much literature in regard is available in this region. Thus, the present study, which will be undertaken relating the morphology of ureter, is an attempt to contribute to existing knowledge in this field and thus benefit the surgeons in conducting safe surgeries in this region. [11-21]

MATERIAL AND METHODS:

The study has been carried out in the Department of Anatomy, Jorhat Medical College and Hospital, Jorhat during years 2014-2015. A total of 160 specimens from 80 cadavers have been studied after fulfilment of all formalities. Specimens are dissected out from adult cadavers given

for undergraduate dissection & foetal cadavers over 32 weeks of age, brought from the Department of Obstetrics and gynaecology, Jorhat Medical College and Hospital, Jorhat. Out of these 15 are adult & 65 are perinatal cadavers.(Adult- 11 male & 4 female and Perinate- 28 male , 37 female) . Routine manual dissection was done to open the abdomen following the instruction of Cunningham’s manual. The morphology, position of ureter, was observed. Specimens collected from them were preserved in a jar containing 10% formalin and studied. Then the length, diameter of ureters(3 measurements) are measured with measuring tape and vernier calliper respectively. The length of intramural parts of ureters were measured by placing probes into the openings of ureters into bladder.

RESULTS:

Participants with the habits were more common in 4th and 5th decade where as In present study, all adult specimens and majority of perinatal specimens show normal morphology of the ureter without any congenital anomaly or developmental variations. 99.38% of the specimens show single ureter. Double ureters were observed in two of the Perinatal female cadaver (1.25%).

TABLE-1: SHOWING SIDE DISTRIBUTION OF NUMBER OF URETER:

NUMBER	RIGHT	LEFT	TOTAL	%
1	79	79	158	98.75
2	1	1	2	1.25

TABLE-2: SHOWING SEX DISTRIBUTION OF NUMBER OF URETER:

NUMBER	MALE	FEMALE	TOTAL	%
1	78	80	158	98.75
2	0	2	2	1.25

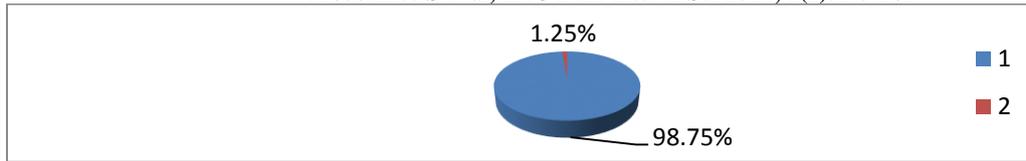


Chart-1: showing percentage distribution of number of ureters

The present study shows the average length of the adult male ureter - 25.78±1.99cm in right side and 26.36±2.06 in left side. In adult females the average length of the ureter is found to be 24.66±1.25cm in right side and 25.33±1.43cm in left side respectively. The average length of the perinatal ureter in males is found to be 6.11±0.56cm in right side and 6.63±0.61cm in left side as well

as in females is 6.02±0.54 cm right side and 6.56±0.56 cm left side respectively. In adults the length of ureter in male is more than female and length of left side is more than of right side. But in perinates there is negligible difference in length of both sexes. There is no statistical significance between the mean ureter length in both sides in adult males and females.

TABLE-3: SHOWING THE AGE, SEX AND SIDE DISTRIBUTION OF LENGTH OF URETER

AGE GROUP			MIN(CM)	MAX(CM)	MEAN	SD
Adult	Male	Right	23	28	25.78	1.99
		Left	23.5	28.5	26.36	2.06
	Female	Right	23	26	24.66	1.25
		Left	23.5	27	25.33	1.43
Perinates	Male	Right	5	7	6.11	0.56
		Left	5.5	7.8	6.63	0.61
	Female	Right	5	7	6.02	0.54
		Left	5.5	7.5	6.56	0.56

In case of adult the average width/diameter of the male ureter is 3.10±0.41mm in right side & 3.10±0.35mm in left side as well as in females, 3.40±0.18 mm in right side and 3.15±0.41mm in left side respectively. The average width/diameter (average of three measurements) of the ureter in perinate

males is found to be 2.85±0.57 mm in right side, 2.61±0.33 mm left side. In perinate females, 2.91±0.36 mm right side and 2.82±0.34mm left side .

TABLE-4: SHOWING AGE WISE DISTRIBUTION OF URETERIC DIAMETERS

AGE GROUP	SEX		MIN(MM)	MAX(MM)	MEAN	SD
Adult	Male	Right	2.4	3.6	3.10	0.41
		Left	2.4	3.6	3.10	0.35
	Female	Right	2.4	3.6	3.40	0.18
		Left	2.7	3.6	3.13	0.41
Perinates	Male	Right	2	3.5	2.75	0.47
		Left	2	3.4	2.61	0.33
	Female	Right	2.3	3.6	2.91	0.36
		Left	2.3	3.7	2.82	0.34

In this study it is observed that there is no statistical significant

difference in diameters of ureters for both sides in male and female adult. In both side mean ureter diameter for female is

slightly more as compared to male perinates. There is no significant difference is seen between the mean ureter diameter in both side for male and female (p=0.469).

In present study, 97.5 % of specimens show normal morphology of ureters. 2.50% of specimens included in present study show anomaly of ureter.

TABLE 5: Showing sex distribution of normal and anomalous ureter

SEX	NORMAL	ANOMALOUS	TOTAL
Male	77	1	78
Female	79	3	82
Total	156	4	160
Percentage (%)	97.50	2.50	

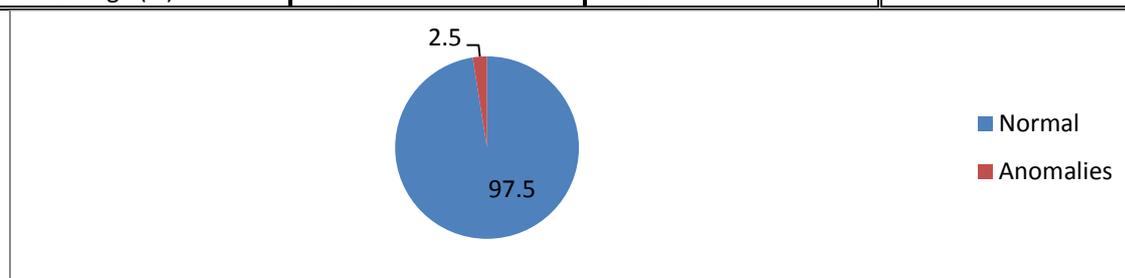


Chart -2: showing the percentage of the normal and anomalies of ureter

There is no statistically significance association between normal & anomalous ureter in both male & female specimens (P =0.5897).

Table-6: showing distribution of congenital anomalies

ANOMALY	TOTAL NO OF SPECIMEN	PERCENTAGE
Double Ureter	1	0.62
Bifid Ureter	1	0.62
Mega Ureter	2	1.25
Ectopic Ureter	0	0
Others	0	0

TABLE-7: Showing side and sex distribution of Congenital Anomalies of ureter

ANOMALY	SEX		SIDE	
	Male	Female	Right	Left
Megaureter	1	1	0	2
Double Ureter	0	2	1	1

TABLE-8: SHOWING SEX DISTRIBUTION OF DOUBLE URETER:

SEX	TOTAL NO OF SPECIMENS	NO OF ANOMALY	% DISTRIBUTION
Male	78	0	0
Female	80	2	1.25

Two case of double ureters were observed among which one right side unilateral double ureter (within a

single fascial sheath) with double pelvis and one left sided bifid ureter were observed in two female perinatal cadaver. The ureters of duplex system open separately into trigon of urinary bladder in complete one. Ureter from upper pole of kidney is longer(6.5 cm in length) than that from the lower pole(6.2

cm in length) .The upper pole ureter inserted medially & below the lower pole ureter in the base of the urinary bladder. The lower pelvis drains more tissue than the upper pelvis. In left sided incomplete double ureter -two ureters were fused in lower part . No anomaly in any other system was observed. (Fig-).

TABLE-9: SHOWING SIDE DISTRIBUTION OF MEGAURETER

SIDE	TOTAL NO OF SPECIMENS	NO OF ANOMALY	% DISTRIBUTION
Male	78	1	1.28
Female	82	1	1.21

In the present study, 2 cases of megaureters one of either sex are observed in two perinatal cadavers. The diameter of ureter in the male specimen is 7.8 mm and in the female specimen is 9.2 mm. In both specimens the ureters consist of a small segment having normal diameter near the bladder distal to dilated segment. Dilatation of pelvis and calices were seen in female specimen but pelvis is normal in male specimen (Fig-).

On observing the findings it was found that, neither perinatal nor adult specimens of both sexes included in the study show any other anomalies like retrocaval ureter, ectopic ureter, ureterocele in the present study.

DISCUSSION:

It is seen from the review of literature regarding Ureter that most of the studies done in adults. Whatever little data related to perinates has been found is discussed here with the findings of present study.

TABLE 10: Showing length of Ureter in adults

WORKER	YEAR	LENGTH IN CM
Stranding S et al	2010	25-30cm
Paick S H	2005	Right- 23.4 +/-1.9 cm Left -24.4+/-2 cm.
Present study	2012-13	Male- Right:25.78±1.99cm Left:26.36±2.06cm Female- Right:24.66±1.25cm Left:25.33±1.43cm

Thus, findings of present study of adult dimensions are correlated with the findings of previous study done by Paick S H(2005) and

Stranding S et al(2010). But Stranding S et al did not mention about the length of right and left side. No worker had described the difference between male

and female ureteric dimensions. The findings of dimension of present study donot correlate with finding of Hellström M (1985) who stated that there is no difference in length of ureters between boys and girls. In in present study in adults the length of ureter in male is more than female and of left side is more than of right side.

Average length of perinatal male ureter is 6.11±0.56cm (range-5-7cm) in right side & 6.63±0.61cm (range 5.5-7.8cm) in left side and the average length

of female ureter is 6.02±0.54cm (range 5-7cm) in right side & 6.65±0.54cm (range 5.5-7.5cm) in left side are observed in present study. The findings of present study in case of perinates could not be compared with any previous study, due to inadequate data regarding the length of the parinatal ureter. The length of perinatal ureters is almost equal or difference is negligible in both sexes in present study.

TABLE 11: SHOWING DIAMETER OF URETER IN ADULTS

WORKER	YEAR	DIAMETER IN MM
Jaeobson B F ¹	1988	Max-7mm
Palkck H M	2000	2-4 mm
Natalie Zelenko	2004	Max- 3mm
Siong Lung Wong	2010	Abdominalpart-4.19±1.27mm, Pelvic part-4.45±1.37 mm
Stranding S at al	2010	3mm
Present study	2012-13	Male- Right:3.10±0.41mm Left:3.10±0.35mm Female- Right:3.40±0.18mm Left:3.13±0.41mm

On observing present study, It is found that the average diameter of perinatal male ureter is 2.85±0.57mm (range-2-4.6mm) in right side & 2.61±0.33mm (range 2-3.4mm) in left side and the average diameter of parinatal female ureter is 2.91±0.36m (range 2.3-3.6mm) in right side & 2.82±0.34mm (range 2.3-3.7mm) in left side . In the left side mean ureteric diameter for female is slightly more as compared to male perinate in the present study.

CONGENITAL ANOMALIES: Congenital anomalies or variations of ureter are common. It may be unilateral or bilateral usually asymptomatic and becomes symptomatic when any pathology occurs

at that site as they are common site for obstruction and infection.

The number of ureter may be double which is a defect in development. In the present study 98.75% of specimens showed normal single ureter. Two unusual cases of double ureter one right sided complete and one left sided incomplete double ureters were observed in two of the perinatal female specimens (1.25%). Stranding S et al (2008) stated that duplication of the ureter results from early splitting of the ureteric bud. Splitting may be partial or complete, and metanephric tissue may be each with its divided into two parts, own renal pelvis and ureter. Russel et al(2000) stated that on an average, 3% excretory urograms

show ureteral duplication on routine examination. Review of world literature suggests that double ureter or bifid ureter is quite common congenital anomaly than other anomalies of ureter. Stranding S at al, 2010 reported incidence of double ureter 1 in 125 individual. Double ureter is a congenital anomaly formed due to some error or disturbance in development of the ureteric bud which arises from the mesonephric duct around the 5th week. Sadler TW (2011) stated, early splitting of the ureteric bud may result in partial or

complete duplication of the ureter. The metanephric tissue may then be divided into two parts, each with its own renal pelvis and ureter. Complete - in which the two ureters drain separately. Complete ureteral duplication may result in one ureter opening normally into the bladder, and the other being normal or ectopic, ending in the vagina, the urethra or the vulval vestibule. These cases occur when the ureteric bud arises twice (rather than splitting).

TABLE 12: SHOWING INCIDENCE OF DOUBLE URETER

WORKER	YEAR	DOUBLE URETER (PERCENTAGE)
Asakawa.M et al	1989	0.5-3%
Russel et al	2000	3%
Setsuko T et al	2008	0.23%
Pujari Dinanath	2011	0.8%
Christopher S Cooper	2004	8%
Present study	2012-13	1.25%

In present study, incidence of double ureter is found to be 1.25% which is more than that of the studies of Asakawa.M et al(1989), Setsuko T et al(2008) and Pujari Dinanath(2011). Nation observed 109 cases of duplication of ureters in 16,000 autopsies with an incidence of 0.68%. Duplex kidneys with double ureters were identified in 1.8% of intravenous urograms performed in 5196 patients by A K Taghizadeh. The double ureters in right side within a single fascial sheath with double pelvis are observed in a female perinatal cadver. The ureters open separately into trigon of urinary bladder. Ureter from upper pole of kidney is longer (6.5 cm in length) than that from the lower pole (6.2 cm in length) and Upper pole ureter inserted medially & below the lower pole ureter in the urinary bladder. The lower pelvis drain more tissue than the upper pelvis. This finding is same as mentioned by Mayer – Weight role (2010) and Stranding S at al (2010). In left sided bifid ureter two ureters with double pelvis fused in lower

part was observed in a female cadaver. No case of double ureter is found in male specimens in present study. 2 cases of megaureter one of either sex in perinatal specimen was observed in present study. The diameter of ureter in case of male specimen is 7.8 mm and in female specimen 9.2 mm. Both cases the ureter consists of a small segment having normal diameter near the bladder distal to dilated segment. Dilatation of pelvis and calices in female but normal pelvis in male specimen is observed.

Alan J. Wein (2007) described that Megaureter are more common in boys than girls, a little more for the left side, and 25% in bilateral. The findings of present study correlate with statements of authors like Hellstrom M et al (1985), Alan J. Wein (2007). Incidence of megaureter in present study is 1.25% and observed in left side.^[2]

OTHER CONGENITAL ANOMALY: On observing the findings of present study it is found that ,neither perinatal nor adult

specimens of both sexes included in the study have shown any other anomalies like retrocaval ureter, ectopic ureter, ureterocele ect. This may attributed to the fact that the case selection for the present study was random and all cases of perinatal deaths have not been included here. Therefore, it does not imply that other anomalies are absolutely not found in this region.

CONCLUSION:

From the present study we come to the conclusion that the ureter exhibits a wide

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