VOLUME - 14, ISSUE - 06, JUNE - 2025 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Anatomy

MORPHOMETRY OF DEVELOPING HUMAN FETAL URETER

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ABSTRACT

Introduction: The ureters are paired bilateral, slender tubular structures connecting the kidneys to the urinary bladder. Developmentally ureter is derived from the ureteric bud which is an outgrowth from mesonephric duct that forms ureter after elongating and penetrating the metanephric blastema. **Objectives:** To study gross morphometric features fetal ureter in different gestational age groups and their correlation. **Methods:** Study was conducted in Anatomy department, in collaboration with Obstetrics and Gynaecology and Pathology departments. Samples obtained were all dead fetuses without any gross congenital malformation ranging between 12 weeks to 36 weeks of gestation. Morphometric parameters were measured and histogenesis at different gestational ages was observed. Data was presented in the form of mean and standard deviation. Quantitative variables were estimated using measures of central tendency, and data was arranged in the form of figures and tables. Pearson's correlation coefficient was calculated between fetal general morphometric parameters, fetal ureteric morphometric parameters, and significant differences were calculated using the ANOVA test. **Results:** The study analyzed the morphometry of fetal ureter during intrauterine life. There was strong positive correlation between General Morphometric parameters of fetus, fetal ureter. **Conclusion:** With advancing gestation age, fetal ureter morphometric parameters increase, which can be used to assess fetal growth and diagnose various pathological conditions. Understanding human fetal ureter morphometry may be of significant assistance in perinatology and Radiology.

KEYWORDS : Fetal ureter, Morphometry, CRL, PUJ, VUJ.

INTRODUCTION

The human urinary system, consisting of kidneys, ureters, urinary bladder, and urethra, is responsible for removing waste, regulating blood volume, blood pressure, electrolytes, metabolites, and blood pH.[1] The muscular layers of the ureter facilitate the peristaltic movements that transport urine from kidneys to the bladder.[2] It starts within renal sinus as funnel shaped dilatation termed as renal pelvis, runs downward and passes into lesser pelvis and opens obliquely into the urinary bladder at lateral angle of trigone.[3,4]

In rare cases, there may be multiple ureters, one opening into the urinary bladder and the other at an abnormal site. Ureters can be incomplete, end in the prostatic urethra, ductus deferens, or rectum, and may have valves or diverticula. Obstruction to urine outflow can occur, and the right ureter may be behind the inferior vena cave, causing kinking and obstruction. Bladder defects may include congenital mega cysts, urachal birth defects, and bladder exstrophy.[5,6,7] To effectively evaluate instances involving developmental defects of the lower urinary tract, an understanding of the Morphometric parameters of the fetal ureter is essential. Nevertheless, the studies are insufficient in quantity, resulting in reported abnormalities that are predominantly normal variants lacking any clinical importance.

Radiologists and obstetricians will comprehend the variations and normative developmental processes, possessing reference data to prevent unwarranted misdiagnosis. It is also beneficial for obstetricians in preserving and enhancing postnatal quality of life. These results will substantially enhance the current literature regarding the intrauterine development of the human ureter. The present study was conducted to study the Morphometry of developing human fetal ureter.

Objectives:

- To study gross morphometric features of human fetal ureter in different gestational age groups and their correlation.
- To determine correlation between morphometric data of human fetal ureters of both sides.

MATERIALS AND METHOD

Study Design:

The study was an observational type of Cross-Sectional Study.

Study Setting:

The present study was done at the department of Anatomy in collaboration with the departments of Obstetrics and Gynecology and Pathology in Moti Lal Nehru Medical College, Prayagraj, after approval from the institutional ethical committee of the institution.

Period Of Study:

The study was conducted from April 2023 to March 2025.

Sampling Unit:

All aborted dead fetuses during study period.

Sample Size:

The estimate for sample size is calculated as 50 in each arm, by using the formula for the study of difference in mean value. Pooled variance (SD^2) and absolute precision have been obtained by considering the mean length of both the sides from previous data.[8] Minimum sample size required was 41, we included 50 dead fetuses satisfying our inclusion criteria.

Sampling Method:

Consecutive sampling method was applied. After approval

from the institutional ethical committee of the institution, fetuses of different gestational age were obtained from the Department of Obstetrics and Gynecology of Swaroop Rani Nehru hospital and various other hospitals of Prayagraj. Informed consent was taken from parents. All Fetuses which were satisfying inclusion criteria were included.

Inclusion Criteria:

All Dead Fetuses From:

- Intrauterine death
- Stillbirth
- Abortions (gestational age <20 weeks or fetal weight <500g)

Exclusion Criteria:

- Fetuses with gross malformation.
- Macerated fetuses.

Methodology:

All 50 Fetuses with known gender and gestational age according to ultrasonography ranging from **13 weeks to 38 weeks** of gestation were included in the study. The known gestational age of fetuses was then co related with respective crown rump length, according to "The Developing Human Clinically Oriented Embryology by Keith L Moore, 10th edition."[9] It helped to confirm their registered gestational age, to rule out any intra uterine growth retardation and conveniently group them according to their gestational age

- Group A-13 to 21 weeks
- GroupB-22 to 30 weeks
- Group C-31 to 38 weeks

After obtaining the fetuses general morphometry was done in which, crown heel length, head circumference, abdominal circumference and chest circumference was measured using measuring tape accurate up to 1mm and thread. The weight of the fetuses was taken by digital weighing machine accurate up to 0.01 gram.

Morphometric Parameters Of Ureter: was measured with the help of thread and scale, vernier calliper accurate up to 0.01mm and weighing machine accurate up to 0.01gram.

- **Right and left ureter length** from hilum to vescico-ureteric junction was measured along the longest axis through a vertical plane.
- **Right and left ureter length** from pelvic-ureteric junction to vescico-ureteric junction was measured along the longest axis through a vertical plane.
- **Right and left ureter diameter (external)** at the level of mid-ureter.
- **Right and left angle of ureter to bladder** was measured from urinary bladder by using pin and protractor.

Data Analysis:

For each gestational age various parameters of fetus and fetal ureter were measured and compiled. Morphometric data was analysed and presented as mean and SD. All quantitative variables were estimated using measures of central tendency (mean) and the data were presented in the form of figures and tables analysed with MS Excel 2019 software. Pearson's correlation coefficient was calculated in between parameters of fetal general morphometry and fetal ureter morphometry and also between various parameters of fetal ureter. Any significant difference with previous studies was calculated with the ANOVA test.

RESULTS:

According to General Morphometry, Mean age in weeks was 24.96 with SD of 6.62 (Range of 13 and 38 weeks). Mean Weight (grams) was 612.40 with SD of 457.76 (Range of 100 and 1984). Mean Crown Rump Length (mm) was 204.78 with SD of 55.89 (Range of 103 and 330). Mean Abdominal Circumference (mm) was 160.22 with SD of 50.25 (Range of 85 and 280).

According to Fetal Ureter Morphometry, Mean Right Ureter Length(mm) from hilum to VUJ was 32.06 with a SD of 9.29. Mean Left Ureter Length(mm) from hilum to VUJ was 32.91 with a SD of 8.51. Mean Left Ureter Length (mm) PUJ to VUJ was 28.37 with a SD of 7.68. Mean Right Ureter Length(mm) PUJ to VUJ was 27.79 with a SD of 8.34. Mean Right Ureter diameter (external)(mm) was 2.17 with a SD of 0.77. Mean Left Ureter diameter (external) (mm) was 2.2 with a SD of 0.84. Mean Right ureter angle was 29.18 degrees with a SD of 10.02 degrees. Mean Left ureter angle was 32.16 degrees with a SD of 11.19 degrees.

As gestational age increases, All the parameters of Foetal ureter increases. There was a statistically significant difference between the morphometric values of Foetal ureter with different Gestational age groups at 13-21 weeks, 22-30 weeks and 31-38 weeks.

There was strong positive correlation between various Fetal Ureteric Parameters with gestation age of Fetus. There is a positive significant correlation between of Left Ureter Length from hilum to VUJ with Right Ureter Length from hilum to VUJ. There is a positive significant correlation between Left Ureter Length from PUJ to VUJ with Right Ureter Length from PUJ to VUJ.

Ureter Length from hilum to VUJ, Ureter Length from PUJ to VUJ, Ureter external diameter, ureter angle on both sides increases with advancing gestational age.

Table 1: Descriptive Statistics Of General Morphometry Of Fetuses.

Variables	Mean	Standard Deviation	Minimum	Maximum
Age (weeks)	24.96	6.62	13	38
Weight (grams)	612.40	457.76	100	1984
Crown Rump Length (mm)	204.78	55.89	103	330
Abdominal Circumference(mm)	160.22	50.25	85	280

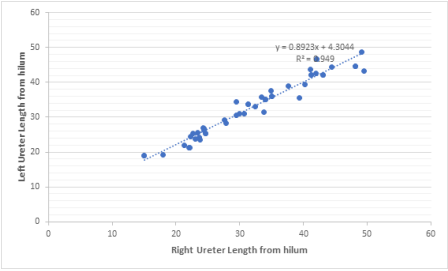
Table 2: Descriptive Statistics According To Fetal Ureter Morphometry

Variables	Mean	Standard Deviation	Minimum	Maximum
Right Ureter Length from hilum to VUJ	32.06	9.29	15.03	49.50
Left Ureter Length from hilum to VUJ	32.91	8.51	19.09	48.69
Left Ureter Length from PUJ to VUJ	28.37	7.68	14.85	43.36
Right Ureter Length from PUJ to VUJ	27.79	8.34	11.06	44.77
Right Ureter diameter (external)	2.17	0.77	0.84	3.73
Left Ureter diameter (external)	2.20	0.84	0.91	4.72
Right ureter angle	29.18	10.02	10	50
Left ureter angle	32.16	11.19	11	52

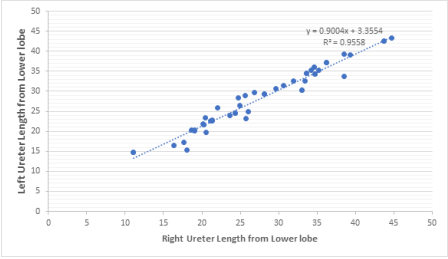
Table 3: Association Of Fetal Ureter Morphometry With Different Gestational Ages

Fetal Ureter Morphometry	Gestational age	Mean	SD	P value
Right Ureter Length from hilum to VUJ	13-21 weeks	22.62	3.58	<0.0001
	22-30 weeks	33.11	5.49	
	31-38 weeks	42.18	5.10	
Left Ureter Length from hilum to VUJ	13-21 weeks	24.04	3.18	<0.0001
	22-30 weeks	34.35	5.29	
	31-38 weeks	41.92	4.29	

Right Ureter Length from PUJ to VUJ	13-21 weeks	19.47	3.98	<0.0001
	22-30 weeks	28.21	4.42	
	31-38 weeks	37.28	4.06	
Left Ureter Length from PUJ to VUJ	13-21 weeks	20.68	3.91	<0.0001
	22-30 weeks	28.76	3.82	
	31-38 weeks	37.17	3.51	
Right Ureter diameter (external)	13-21 weeks	1.71	0.53	<0.0001
	22-30 weeks	1.96	0.51	
	31-38 weeks	2.96	0.68	
Left Ureter external diameter	13-21 weeks	1.56	0.42	<0.0001
	22-30 weeks	2.27	0.53	
	31-38 weeks	2.89	0.95	
Right ureter angle	13-21 weeks	24.78	13.11	0.06
	22-30 weeks	31.24	7.44	
	31-38 weeks	32.13	6.30	
Left ureter angle	13-21 weeks	26.22	11.73	0.014
	22-30 weeks	34.53	8.13	
	31-38 weeks	36.60	11.06	



Graph 1: Correlation of Right Ureter Length from hilum to VUJ with Left Ureter Length from hilum to VUJ



Graph 2: Correlation of Right Ureter Length from PUJ To VUJ with Left Ureter Length from PUJ to VUJ

DISCUSSION:

In present study, according to General Morphometry, mean age in weeks was 24.96 with SD of 6.62 (Range of 13 and 38). There was a statistically significant difference between General Morphometry with Different Gestational ages at 13-21 weeks, 22-30 weeks and 31-38 weeks (p-value <0.0001). In a study done by **Devi Y et al (2019)**[10], found that as gestational age advances, crown rump length increased. In a study done by **Islam M et al (2013)**[11], Male ureter length was longer than female and the difference was statistically significant. The oblique trajectory of the intravesical ureter contributes to the passive anti-reflux mechanism. This is accomplished by neutralising the force that tends to separate the ureteral roof from the floor. Our study findings were consistent with findings of **Joshi R et al (2020)**[9], who found that Length from hilum to VUJ, diameter of right and left Ureter increases with advancing gestational age.

In present study, mean Left Ureter Length from PUJ to VUJ 28.37 with a SD of 7.68 mm and mean Right Ureter Length from PUJ to VUJ 27.79 with a SD of 8.34 mm. In a study done by **Martis PJ (2018)**[12], The length of the ureter from the PUJ to the VUJ ranged on the right side from 22 ± 2 mm to 59 ± 1 mm and on the left side from 22 ± 1 mm to 66 ± 1.5 mm. when length of ureter is correlated with gestational age, there was highly positive correlation (r=0.9) with increasing gestational age. Ultrasonographic assessment of Fetal Ureter correlated with increasing gestational age may reveal pathology of Fetal Ureter and help in early identification of Fetal Ureter pathologies.

CONCLUSION:

Ureter Length from hilum to VUJ, from PUJ to VUJ, external diameter, ureter angle on both sides increases with advancing gestational age. As gestational age increases, all parameters of Foetal ureter Morphometry values increases. There was a statistically significant difference between the morphometric values of Foetal ureter with different Gestational age groups. With advancing gestation age, fetal ureter morphometric parameters increase, which can be used to assess fetal growth and diagnose various pathological conditions. Understanding human fetal ureter morphometry may be of significant assistance in perinatology and Radiology.

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