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Right Kidney Anomaly: Incomplete Bifid Collecting System observed in an Adult Black African Female Cadaver

Ayonga Warren Oyale[1], Khisa Wanjala Allan[2*], Aswani Clevin Wakhisi[3], Lwunza Hans Libamila[4], Papa Stella Imade[5], Uluma Wanjala Edwin[6], Otieno Olgah Anyango[7], Zari Gwazi Maumba[8], Brimin Apopo[9], Paul Oyako[10], Joshua Wekesa[11] & Timothy Nyandemo[12]

[1,4,6-12]Department of Human Anatomy, School of Medicine, Maseno University, Kisumu, Kenya. [2,3]Department of Clinical Medicine, School of Health Sciences, Karatina University, Nyeri, Kenya. [5]Department of Clinical Medicine, School of Health Sciences, Kaimosi Friends University, Vihiga, Kenya. Corresponding Author (Khisa Wanjala Allan) Email: allanwanjala345@gmail.com[*]

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ABSTRACT

Background: This cadaveric report describes an incomplete duplicated ureter of the right kidney in an adult female cadaver. Dissection of the abdomen was performed, both right and left kidney exposed insitu. **Results:** It was observed that the right kidney had two ureters that converged at the level of Anterior Superior Iliac Spine just before entering the urinary bladder while left kidney had a single ureter running through to urinary bladder. The length of duplicated ureters of right kidney was 19.5 cm and 18.0cm respectively. On the right kidney, bifid ureters emerged each from its own renal pelvis while on left, single ureter emerged from a single pelvis which is normal. On the right kidney, each renal pelvis was formed from their own major and minor calyxes. The upper renal pelvis drained the kidney on superior aspect and lower renal pelvis drained inferior aspects of kidney. All other internal parts of right kidney were normal. **Conclusion:** In conclusion, this variation is due to embryological malformation of the ureteric bud therefore, it is asymptomatic however can be associated with incontinence or uropathies later on in life.

Keywords: Asymptomatic; Blastema; Cadaver; Calyx; Duplex; Insitu; Incontinence; Kidney; Metanephric; Ureter; Uropathy.

1. Introduction

The urinary system is a systemic component of human body that is composed of kidney, ureter, bladder and urethra. The kidneys are bilateral organs of urinary system with its main function being filtration of waste substances from blood and maintaining balance of body fluids. The blood is filtered at renal corpuscle to form urine which is transported to renal papilla through the nephron tubule system (Ridley & Ridley, 2018). Once urine reaches renal papilla it's channelled to renal ureter through calyxes and renal pelvis. Normally each kidney is drained by a single ureter. It is narrow thick walled expansile muscular tube that conveys urine from the kidney to the urinary bladder. It is 25 cm (10 inches) in length and 3mm in diameter. It begins as a downward continuation of a funnel shaped renal pelvis. It has abdominal and pelvic parts. The urine is usually propelled from kidney to urinary bladder by peristaltic contraction of smooth muscles within the wall of ureter.

Duplicate ureteral collecting system can be classified as complete or incomplete. Complete is where a single kidney has two distinct and comprehensive collecting systems each with its individual renal pelvis, ureter and urethral opening into the bladder. Incomplete duplex is where a single kidney has two separate ureters but these ureters join before draining into the bladder. It occurs due to bifurcation of ureteric bud preceding its invasion into metanephric blastema. It can be Y shaped in appearance if it joins before the ureteropelvic junction or V shaped which joins after.

A unilateral double ureter occurs in 0.8% of individuals while bilateral double ureters happen in approximately 1.125% (Gebreziher et al., 2024; Subramaniam & Springer, 2023). Duplicated ureter commonly occurs in females than males and is frequently on the left side. It can be asymptomatic or related to vesicoureteral reflux, ureterocele,

incontinence, or obstructive Uropathy. It can also lead to dysplasia, renal parenchymal scarring or decreased kidney function (Carlson, 2023; Moustapha et al., 2023).

Complete ureteric duplication has two continuous ureters draining to separate openings in the bladder where ureter draining from lower pole is called orthotopic while the one from upper pole is ectopic, as per Weigert–Meyer rule. This congenital malformation happens during development of metanephric system which arises from the premature splitting of ureteric bud leading to development of two separate buds. Abnormal splitting of ureteric bud can develop from improper function of Glial cell line derived neurotrophic factor (GDNF) and RET which are biological inducers of ureteric bud development and growth (Di Franco et al., 2017; Kagantsov et al., 2022; Mishra & Elliott, 2017).

1.1. Study Objectives

The primary aims of this study were: 1) to establish the presence of a duplex collecting system, 2) to determine the areas of origin of the two bifid ureters, 3) to determine the level at which the bifid ureters unite before joining the urinary bladder, 4) to determine the course of the bifid ureters alongside their length, and 5) to establish its relationship in embryological context and evaluate whether such is clinically asymptomatic or symptomatic.

2. Case Report

During an academic dissection of formaldehyde and phenol fixed black African female cadaver, we noted a bifid ureter emerging from right kidney in right renal fossa. Its arterial blood supply arose from abdominal aorta and drained into inferior vena cava (IVC). Right testicular vein was not preserved during dissection therefore its drainage could not be confirmed.

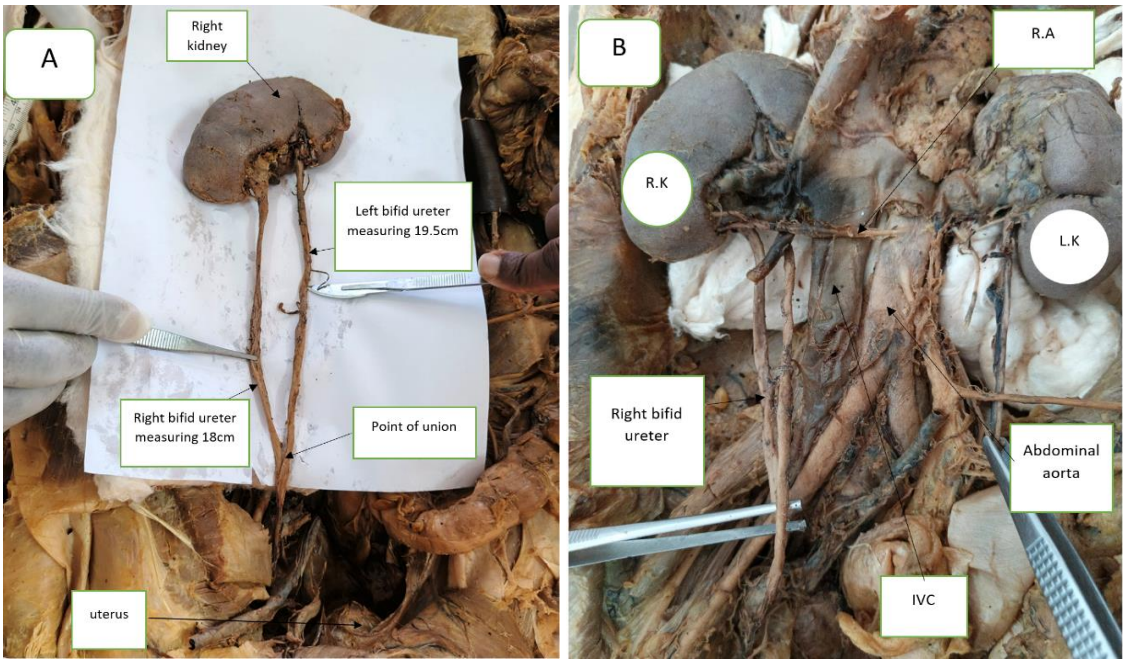

Figure 1. A- shows right kidney with bifid ureters that unite at the level of pelvic brim before draining in urinary bladder while **B-** shows R.K (right kidney), IVC (inferior vena cava), R.A (renal artery) and L.K (left kidney). Right kidney is slightly lower than left kidney while renal veins and artery can be seen entering the renal hilum.

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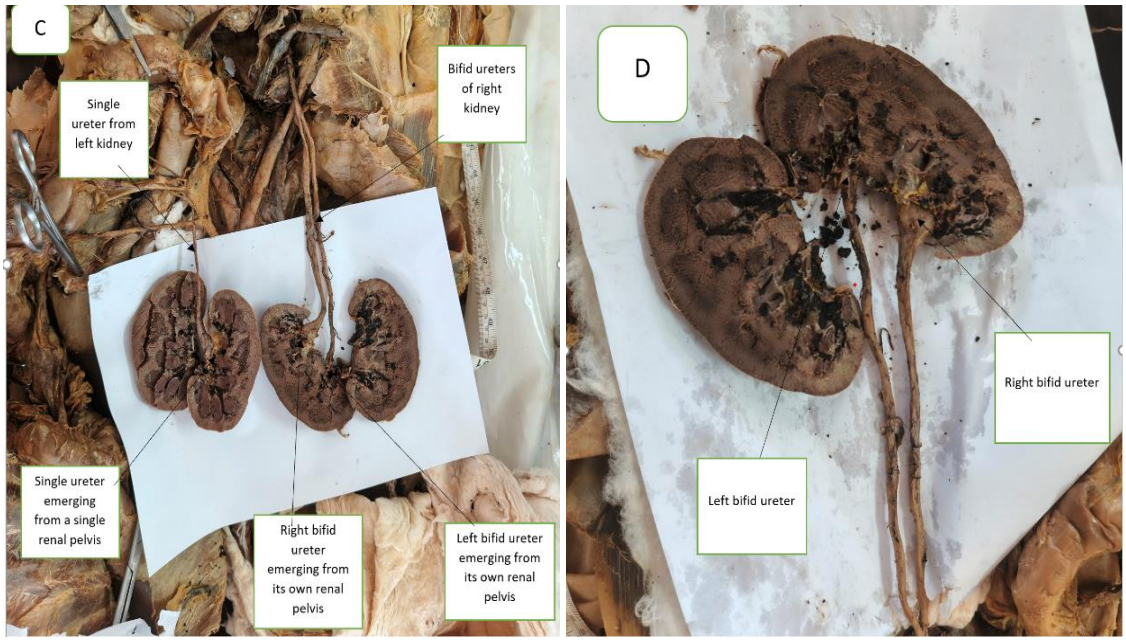

Figure 2. C- shows a comparative cross section of right and left kidney whereas **D**- shows the right bifid ureters each emerging from its own renal pelvis.

On the left renal fossa, left kidney was present with a single ureter draining into urinary bladder. The left testicular vein was visualized hence its drainage could be confirmed. The right kidney measurement was 11cm from superior to inferior pole, 5.5cm medial to lateral border while left kidney had a measurement of 10.0cm and 4.5cm respectively. The left bifid ureter emerged from the upper portion of the kidney measuring 19.5 cm to the point of bifurcation whereas right emerged from lower portion of the kidney measuring 18.0cm. It was observed that the bifid ureter united at the level of anterior superior iliac spine (ASIS) or pelvic brim where its abdominal part ends and its renal part starts. Both ureters were seen entering the urinary bladder but ureteric orifices could not be appreciated.

On further dissection, cross section of both kidneys was made where on the right kidney, bifid ureters emerged each from its own renal pelvis while on the left, single ureter emerged from a single pelvis which is normal. On the right kidney, each renal pelvis was formed from their own major and minor calyxes. The upper renal pelvis drained the kidney on superior aspect and lower renal pelvis drained inferior aspects of kidney. All other internal parts of right kidney were normal. On dissection of left kidney, a single renal pelvis with emergency of single ureter was seen. The major and minor calyxes were observed each forming a single renal pelvis which is normal anatomy.

3. Discussion

During cadaveric dissections, bifid ureters have been reported in about 0.8% of the cadavers (Arumugam et al., 2020) .Studies by (Kanasker et al., 2020) showed that 3% of such cases are higher in females as compared to males although the cause is not well documented .Similarly unilateral bifid ureters are six times more in comparison to bilateral duplication. A study by (Mugunthan et al., 2016) showed that there exists a 6% incidence of bifid ureter and multiple renal arteries. This congenital anomaly usually occurs during fetal development of collecting duct from the metanephric system .Normally, both right and left collecting ducts result from ureteric bud which initially

penetrates metanephric mesoderm and later undergoes repeated branching to form two ureters, renal pelvis, major and minor calyces as well as collecting ducts (Leo, 2023; Tam & Pauls, 2021). The paired system develops from a premature separation of ureteric bud or development of two bifurcate buds.

Ureteric bifurcation is majorly embryological and can be complete or incomplete (Seu et al., 2024). The right bifid variant ureter in the current study, concurs with study done by (Seu et al., 2024) in Korean population which reported left unilateral incomplete duplication of ureter, the two ureters formed a Y shaped pattern converging at the anterior superior iliac spine , it also showed dual calyceal system with the bifid ureter originating from separate major calyxes and renal pelvis as the current study. Another study by (Roy et al., 2017) done in India on 156 cadavers reported 0.64% incidence of ureteral duplication which was complete unlike our current study. (Kumaran & Chitra, 2019) study reported a case of incomplete duplication of ureters which had separate pelvicalyceal systems, joining before entering the bladder. Unilateral bifurcation of the ureter maybe due to bifurcation of ureteric bud prior to its invasion into metanephric bud (Roy et al., 2017).

In typical renal sinus anatomy, all renal papillae, minor calyces, and major calyces converge into a single renal pelvis, which subsequently drains into a solitary ureter that transports urine to the bladder. However, in this case, the renal papillae, minor and major calyces, and the renal pelvis are divided into two distinct groups: one positioned superiorly and the other inferiorly. The renal pelvis located in the superior portion specifically drains the nephrons situated in the upper region, while the renal pelvis in the inferior section drains the nephrons found in the lower region of the kidney. This anatomical variation represents a deviation from the conventional structure of the urinary sinus (Naidoo et al., 2023).

4. Conclusion

It can be concluded that these findings provide valuable clinical insights for performing a partial nephrectomy through laparoscopic intervention, particularly when approaching the renal hilum. Understanding the normal embryological development of the urinary system can give a hint of such malformation. For this case it is more likely that this variant might have been as results of formation of two ureteric buds in one kidney thus resulting in incomplete duplex kidney. It is vital to note that such conditions might be asymptomatic although they can be linked to incontinence or uropathies later on.

Future studies can be conducted:

1) To establish if there is a difference in terms of gender for the above anatomical variation.
2) To determine if such a condition is prevalent in certain ethnic groups.
3) To establish the difference in gender and racial groups in reference to such anatomical variation.
4) To establish relationship of such anatomical variations to its related structures around it.

Declarations

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Competing Interests Statement

There are no competing interests and this study did not receive any kind of funding of which ever kind.

Consent for publication

All the authors contributed to the manuscript and consented to the publication of this research work.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

Ethical Approval

Approval to collect this data was sort from the Department of Human Anatomy as this was during the normal academic process.

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Availability of data and materials

Not applicable.

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