Case Report

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BIFID URETER AND ITS CLINICAL SIGNIFICANCE: A CADAVERIC STUDY

M Danish M Jeelani Shaikh [1]*, Gurunath Digambar Khanolkar [2]

[1] PG Scholar, Rachana Sharir Department, R A Podar Ayu Medical College, Worli, Mumbai, Maharashtra, India

[2] Associate Professor & HOD, Rachana Sharir Department, R A Podar Ayu Medical College, Worli, Mumbai, Maharashtra, India

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***Corresponding author**

E-mail: danishshaikh7012@gmail.com

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ABSTRACT

Aim: The aim of this study is to document the incidence, morphological features, and clinical implications of bifid ureter through cadaveric examination, contributing to a better understanding of renal and ureteral anatomical anomalies and their clinical relevance. Methods: A 68-year-old male cadaver was used in this study, obtained from Cooper Medical College & Hospital, Mumbai, with all necessary ethical approvals and documentation (No Objection Certificate and death certificate). Detailed dissection of the renal and ureteral structures was conducted to observe anatomical variations. The ureteric anomaly was characterized, and associated vascular variations were noted. The findings were compared with previous literature. Results: The right kidney exhibited an incomplete bifid ureter, with two ureters originating from the renal pelvis, crossing each other before converging into a single opening in the bladder in a Y-shaped pattern. Several vascular anomalies were also noted, including two accessory renal arteries on the right side and an unusual venous connection involving the left renal vein. Additionally, gonadal vascular variations were observed, where both gonadal arteries originated from the accessory renal arteries. Discussion: The observed incomplete bifid ureter and associated renal and vascular anomalies highlight the complex nature of renal anatomy. These variations can complicate diagnostic imaging and surgical procedures. The findings underscore the importance of recognizing these anomalies for accurate diagnosis, surgical planning, and the prevention of potential complications. Conclusion: This cadaveric study provides valuable insights into the anatomical variations of bifid ureter and associated vascular anomalies. Understanding these variations is crucial for clinicians involved in renal surgeries, diagnostic imaging, and the management of related complications.

Keywords: Bifid ureter, renal anomalies, cadaveric study, accessory renal arteries, ureteral duplication.

INTRODUCTION

Bifid ureter is a congenital anomaly characterized by the duplication of the ureteric structure, arising from abnormal division of the ureteric bud during early renal development. This condition may present as either complete duplication, where each ureter has an independent opening into the bladder, or incomplete duplication, where the two ureters merge before reaching the bladder. The reported incidence of bifid ureter in the general population ranges from 1% to 10%, with an average occurrence around 5%, depending on detection methods. [1]

Although often asymptomatic and discovered incidentally, bifid ureter can be associated with complications such as vesicoureteral reflux, urinary tract infections, hydronephrosis, and renal calculi, which may impair renal function. Cadaveric studies play a critical role in identifying such anatomical anomalies, offering direct visualization of renal and ureteral structures. These studies contribute valuable information for clinical diagnosis, radiological interpretation, and surgical planning, particularly in renal transplantation and ureteral reconstruction.

The objective of this research is to document the incidence, morphological features, and clinical implications of bifid ureter through cadaveric examination, thereby improving anatomical understanding and informing diagnostic and therapeutic strategies.

MATERIALS AND METHODS

The cadaver used in this study was obtained from Cooper Medical College and Hospital, Mumbai, for academic purposes. All necessary ethical approvals and regulatory permissions were obtained prior to the use of the cadaver. A No Objection Certificate (NOC) was provided by the hospital, confirming the use of the cadaver for academic and research purposes. Additionally, the death certificate of the individual was also obtained as part of the required documentation. The cadaver was studied in compliance with institutional ethical standards and relevant local regulations governing the use of human cadaver for educational and research purposes.

Case Report

During the 2023–24 academic year, a case of incomplete ureter duplication (bifid ureter) was observed in the right kidney of a 68-year-old male cadaver. The two ureters originated from the renal pelvis, with Ureter 1 positioned medially to Ureter 2, which crossed behind it before merging in a Y-shaped pattern just above the anterior superior iliac spine, entering the bladder through a single opening. [Figure 1 (A), (B)]

In addition to the ureteric anomaly, several notable vascular variations were observed. Two accessory renal arteries, smaller than the main renal artery, originated from the abdominal aorta, providing additional blood supply to the right kidney. Similarly, an accessory renal artery entered the left kidney at its lower pole. Accessory renal arteries are present in about 40% of individuals and can be crucial during surgical procedures, as their injury could lead to renal ischemia. Additionally, an unusual venous connection was noted, where multiple branches entered the left renal vein, further complicating the typical venous anatomy of the kidney. [Figure 2 (A), (B)]

Gonadal vascular abnormalities were also present. Both the right and left gonadal arteries arose from the accessory renal arteries at the lower poles of the kidneys—a variation from the usual pattern, where the gonadal arteries originate directly from the abdominal aorta. Furthermore, the right gonadal vein drained into the renal vein, deviating from the typical drainage into the inferior vena cava. [Figure 3]

These vascular anomalies can complicate diagnostic imaging and surgical interventions, making it essential for clinicians to be aware of such variations to avoid misinterpretation or surgical complications. These findings underscore the complexity of renal and gonadal vascular anatomy and its potential clinical significance.

Normal Anatomy and Embryology Overview

The ureter develops from the ureteric bud, which arises from the mesonephric duct during the 4th week of embryonic development. The bud grows toward the metanephros, the precursor to the kidney, inducing the formation of renal structures like the renal pelvis and nephrons. As the ureteric bud elongates, the proximal part forms the renal pelvis, and the distal part becomes the ureter, which connects the kidney to the bladder by the 8th week. If the ureteric bud splits prematurely, it leads to the formation of a bifid ureter, where two ureters arise from a single kidney. [2]

Previous Works

- **Moinuddin and Dhanda (2015)** reported that complete ureteric duplication is the most common form. In such cases, the lower pole ureter typically drains the majority of the kidney and opens cranially and laterally into the bladder. [3]
- **Ojha and Prakash (2016)** noted that in cases of bifid ureter, both ureters pass superficially to the renal artery and then run parallel to each other. [4]
- **Anjana *et al.* (2017)** observed that 79% of specimens had an intrarenal renal pelvis, and a bicalyceal configuration with two major calyces was the most common pattern.[5]
- **Shakthi Kumaran and Chitra (2019)** described a case of unilateral incomplete duplication where the two ureters crossed each other twice before converging just prior to entering the bladder. [6]
- **Protoshchak *et al.* (2020)** characterized bifid ureters as uncommon variants, with low fusion occurring within the intramural part of the urinary bladder.[7]
- **Seu *et al.* (2024)** observed bifid ureters originating from separate major calyces and renal pelvis, with one ureter traversing anterior to the renal vessels and the other posterior.[8]
- **Kaneko *et al.* (2008)** reported that polar or auxiliary renal arteries are present in approximately 25% of cases involving multiple renal arteries. [9]
- **William P. *et al.*, Gray's Anatomy, 38th ed. (1995)** and **Madhyastha S. *et al.* (2001)** reported that accessory renal arteries are present in about 40% of individuals, often originating from the aorta either above or below the main renal artery. [10, 11]
- **Juan Jose (2024)** found that the overall prevalence of multiple renal veins was 5%, with 3% showing bifurcated renal veins and 2% exhibiting unusual renal venous anatomy.[12]

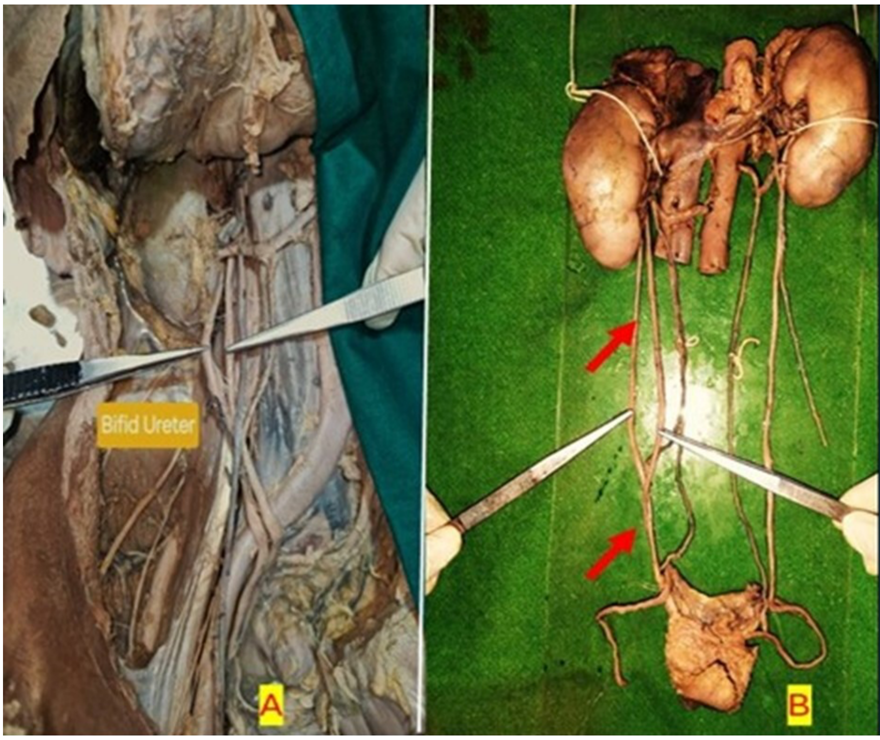


Fig 1 (A) : A bifid Ureter is seen in Right side Kidney of cadaver.

Fig 1 (B): The two ureters originated from the right kidney and merged just before entering the urinary bladder.

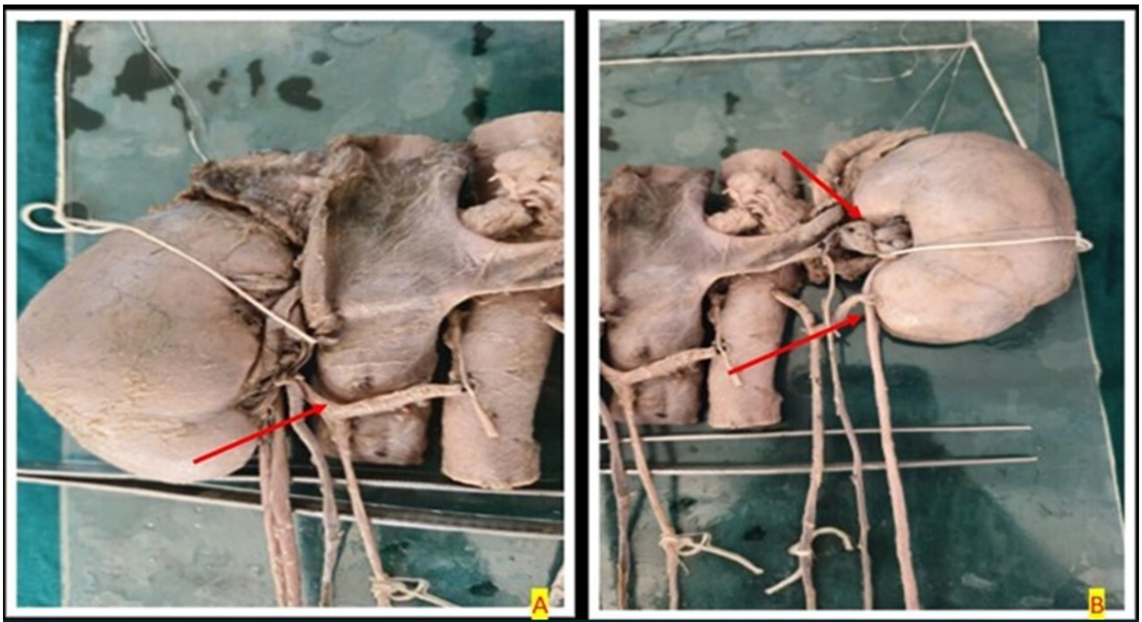
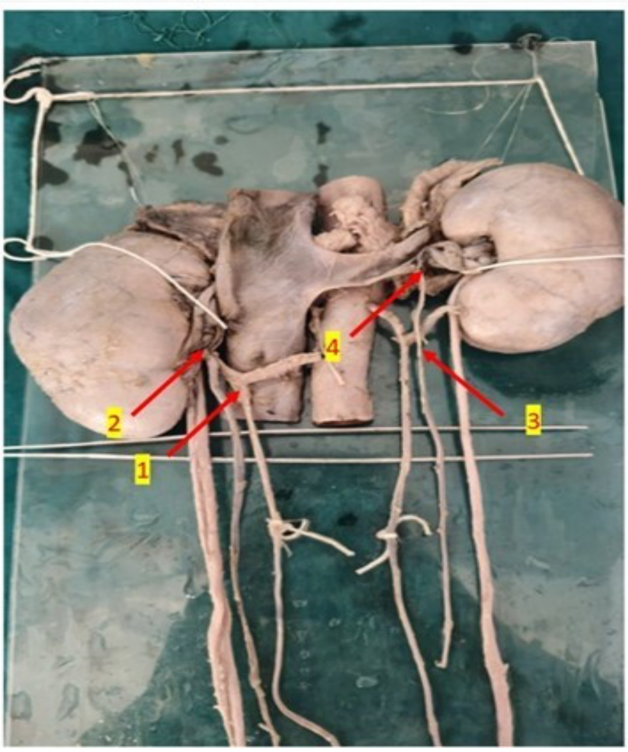


Fig 2 (A) Right Kidney shows two accessory renal arteries.
Fig 2 (B) Left Kidney shows an accessory renal artery arising from the lower pole of the kidney.



Fig(3): Both the right and left gonadal arteries arose from the accessory renal arteries.(1)(3).
The right gonadal vein drain into right renal vein.(2)
The left gonadal vein drain into left renal vein.(Normal)(4).

RESULT AND DISCUSSION

This case of incomplete ureteral duplication, observed in a 68-year-old male cadaver, offers valuable insights into renal anatomical variations, particularly involving the bifid ureter. The Y-shaped confluence of the ureters just before entering the bladder, anterior to the psoas major muscle and iliac spine, is a noteworthy feature.

Previous studies, such as Moinuddin and Dhanda (2015) [3], described complete ureteric duplication, where the lower pole ureter typically drains the majority of the kidney. Our case differs from this pattern, as Ureter 1 and Ureter 2 originated at different levels within the renal pelvis and exhibited a crossing pattern before merging—unlike the parallel course observed by Ojha and Prakash (2016) [4-5]. Additionally, Shakthi Kumaran and Chitra (2019) [6] described a similar case of incomplete duplication, but the Y-shaped configuration in our observation presents a unique anatomical variation not commonly reported in the literature.

Beyond the ureteric anomaly, we observed significant renal vascular variations. Accessory renal arteries, present in approximately 40% of individuals, were identified—specifically, two smaller arteries originating from the abdominal aorta supplying the right kidney. These vessels are of particular clinical importance, as injury during surgery may result in segmental renal ischemia. Our case also revealed an additional venous connection to the renal vein, aligning with findings reported by Kaneko et al. (2008) [9] and others, who noted variations in renal venous anatomy.

The coexistence of ureteric and renal vascular anomalies increases the complexity of renal surgery and diagnostic imaging, emphasizing the need for thorough anatomical knowledge during preoperative planning. Such anomalies may be overlooked during imaging or misinterpreted as pathological findings, potentially leading to diagnostic or surgical errors.

This case contributes to the growing body of literature on renal and ureteral anatomical variations and underscores their relevance in clinical practice. Recognition of these variations is essential for accurate diagnosis, effective surgical intervention, and prevention of complications.

CONCLUSION

In this cadaveric study, we presented a case of incomplete bifid ureter in a 68-year-old male, demonstrating a rare anatomical variation where two ureters originated from the right kidney and converged just before entering the bladder. This case highlights the importance of understanding the diverse presentations of bifid ureter, as such anomalies can have significant clinical implications, especially in imaging, diagnosis, and surgical planning.

Our findings, when considered alongside previous studies, emphasize the need for careful evaluation of ureteral duplications to detect potential complications such as vesicoureteral reflux, hydronephrosis, and urinary tract infections. The additional observation of vascular anomalies, including accessory renal arteries and atypical venous drainage, further underscores the complexity of renal anatomy.

Cadaveric research remains an invaluable method for identifying and understanding such variations. By enhancing our anatomical knowledge, these studies contribute to more accurate diagnostic approaches and therapeutic strategies, ultimately improving patient outcomes in clinical practice.

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