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Original Research

Let's unravel the association between renal stones and renal variant vasculature in patients with duplex collecting system: A retrospective single institute study

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Abstract

Background: Our study aims to explore the association of duplex collecting systems with variable renal vasculature and renal calculi, given the paucity of published data on the subject.

Methodology: Between 2020 and 2023, retrospective research on patients with a duplex collecting system detected by CT scans was conducted at the radiology department of Shifa International Hospital. We assessed any gender bias and ascertained the frequency of this unilateral or bilateral duplex system abnormality. Furthermore, in patients who had received post-contrast imaging, the prevalence of renal calculi and varied renal vasculature was evaluated. In individuals with a duplex collecting system, the correlation between renal stones and renal variant vasculature was computed. SPSS version 25 was used to conduct the chi-square test.

Results: We retrospectively gathered data on patients with duplex collecting systems that showed only 65 patients. According to our research, bilateral participation is uncommon but the duplex collecting system is not side-specific. According to our statistics, this aberration has been more common in men as compared to women. Only 36 of the 65 patients in total had post-contrast imaging to check for variances in the vasculature. Of the 36 patients with renal vein variations, 11 had renal vein variations and 25 did not have any anatomical variations. Of the 25 individuals who did not have a renal vein variation, 19 did not have calculus, 2 had calculus involving the lower pole, and 4 had calculus involving the upper pole. 8 individuals with renal variations did not have renal calculus, 2 patients had lower pole calculus, and 1 patient had upper pole calculus. A negative uncertainty coefficient was seen between renal vein vasculature and calculus formation. 17 of the 36 patients had renal artery variations, whereas 19 patients had no anatomic variation of the renal artery. 12 of the 19 individuals without a renal artery variation had no calculus, 2 had calculus involving the lower pole, and 5 had calculus involving the upper pole. 2 individuals had calculus affecting the lower pole, 0 patients had calculus on the upper pole, and 15 patients with renal artery variations had no renal calculus. A positive uncertainty coefficient was seen between renal arterial vasculature and calculus formation.

Conclusion: Understanding renal vasculature patterns is vital for effective vascular interventions as well as kidney transplantations. Patients with a duplex collecting system are at increased risk of stasis, infections, and stone formation. For urologists and nephrologists, awareness of the association with variant renal vasculature is critical for managing complications related to this anomaly.

Keywords: Renal Calculus; Renal Vasculature; Duplex Collecting System; Radiology; Pakistan.

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Quick Response Code:

Introduction:

A duplex collecting system is a common congenital abnormality that can be complicated by urinary tract calculus. Renal vasculature is known to display a wide variety of variations. The association between renal calculi and variant renal vasculature is rarely reported in the literature. For nephrologists and urologists, awareness of this association is critical for appropriate management. While abnormalities of the collecting system and renal arteries are very common, it is uncommon for them to occur together [1]. One type of congenital genitourinary tract malformation is called a duplex collecting system (DCS). It is detected in 0.3% of excretory urograms bilaterally [2]. Since the majority of patients have no symptoms and the abnormality is often discovered by accident, it is challenging to determine the precise prevalence of this aberration [3]. The urinary tract defect known as the duplex collecting system is caused by an incomplete fusion of the upper and lower pole moieties. Partial or whole duplication is possible (Y-shaped ureter) [4]. While inadequate duplication causes two ureters to drain the same kidney but merge before they reach the bladder, complete duplication results in two patent ureters emerging from the damaged kidney and draining independently into the bladder [5]. Renal vasculature is known to display a wide variety of variations. Understanding these patterns has become more important not only for kidney transplantation but also because vascular intervention for renal artery stenosis, open surgery or endovascular stenting for abdominal aortic aneurysm, and nephrectomy all require an understanding of the architecture of the vasculature [6].

Methodology:

Institutional review board and ethical committee approval was taken as per the ethical guidelines of the hospital board. Afterward, we retrospectively identified individuals who were diagnosed with a duplex collecting system using CT scans that were done at Shifa International Hospital's radiology department between 2020 and 2023. Siemens 128-slice, Siemens 16-slice, and Toshiba 640-slice CT scanners were used to perform the scans. We evaluated any gender bias and determined the prevalence of this aberration of the duplex system, whether unilateral or bilateral. In addition, the incidence of renal calculi and variable renal vasculature was assessed in individuals who had undergone post-contrast imaging. The association between renal stones and renal variant vasculature in patients with duplex collecting systems is calculated. The Chi-square test was performed using SPSS v25.

Results:

Over the period of 3 years, we retrospectively collected data on patients having duplex collecting systems that came out to be in 65 patients. The duplex collecting system was seen on the right side in 28 patients (43.1%), on the left side in 28 patients (43.1%), and involving bilateral sides in 9 patients (13.8%). Our data showed that the duplex collecting system is not side-specific, however, bilateral involvement is seen seldom.

Amongst these 65 patients, 37 were males and 28 were females, corresponding to 56.9 and 43.1% respectively. Our data shows that the male gender has been more prone to this anomaly, seen in 37 patients as described above.

So, amongst over total of 65 patients only 36 patients have post-contrast imaging to look for vasculature variances.

For the renal vein variants within these 36 patients, 25 patients had no anatomic variant of the renal vein while 11 had renal vein variants. In patients having no renal vein variant (25 patients), 19 patients had no calculus, 2 patients had calculus involving the lower pole and 4 patients had calculus involving the upper pole. In patients having renal variances, 8 patients had no renal calculus, 2 patients had calculus involving

the lower pole and 1 patient had calculus on the upper pole. A total of 27 patients had no calculus, 4 patients had lower pole calculus, and 5 patients had upper pole calculus.

For the renal artery variants within these 36 patients, 19 patients had no anatomic variant of renal artery while 17 had renal artery variants. In patients having no renal artery variant (19 patients), 12 patients had no calculus, 2 patients had calculus involving the lower pole and 5 patients had calculus involving the upper pole. In patients having renal artery variances, 15 patients had no renal calculus, 2 patients had calculus involving the lower pole and 0 patients had calculus on the upper pole. The total of 27 patients had no calculus, 4 patients had lower pole calculus, and 5 patients' upper pole calculus.

When calculating the uncertainty coefficient while calculating the association of renal vein variants with calculus formation, it turned out to be 0.622 (negative association). See Figure 1.

When calculating the uncertainty coefficient while calculating the association of renal artery variants with calculus formation, it turned out to be 0.028 (positive association). See Figure 2.

Images of the renal calculi and renal vascular variants are shown in Figure 3 and 4.

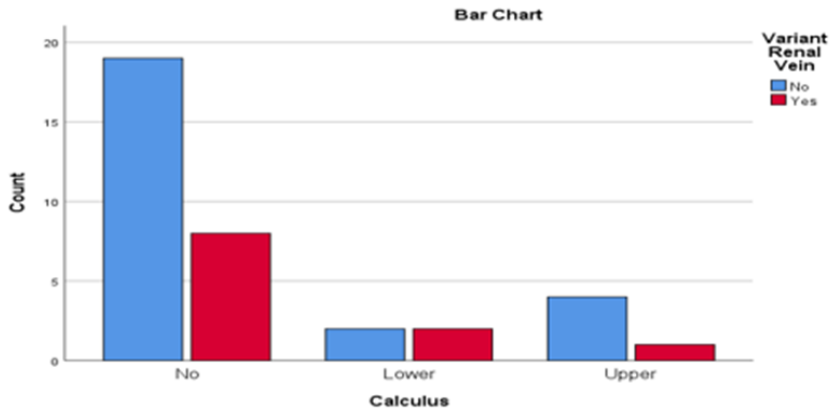

Figure 1: Bar chart showing the association of renal vein variants with renal calculi. (Stats: Uncertainty coefficient = 0.622; Negative Association)

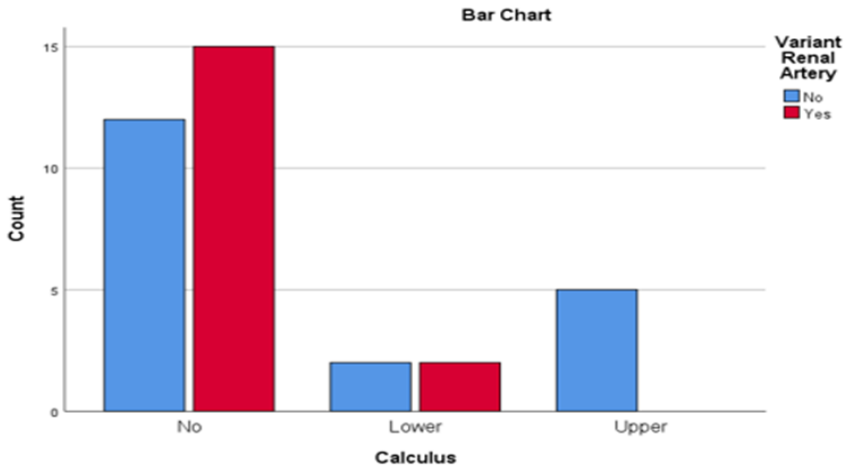

Figure 2: Bar chart showing the association of renal artery variant with renal calculi. (Stats: Uncertainty coefficient = 0.028; Positive Association)

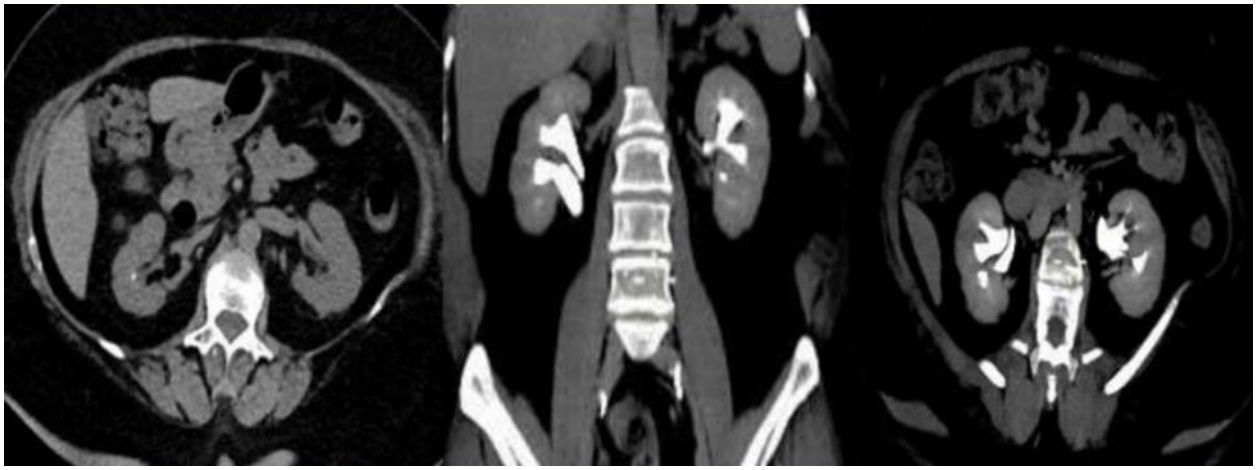

Figure 3: Multiplanar CT duplex collecting system and renal calculi.

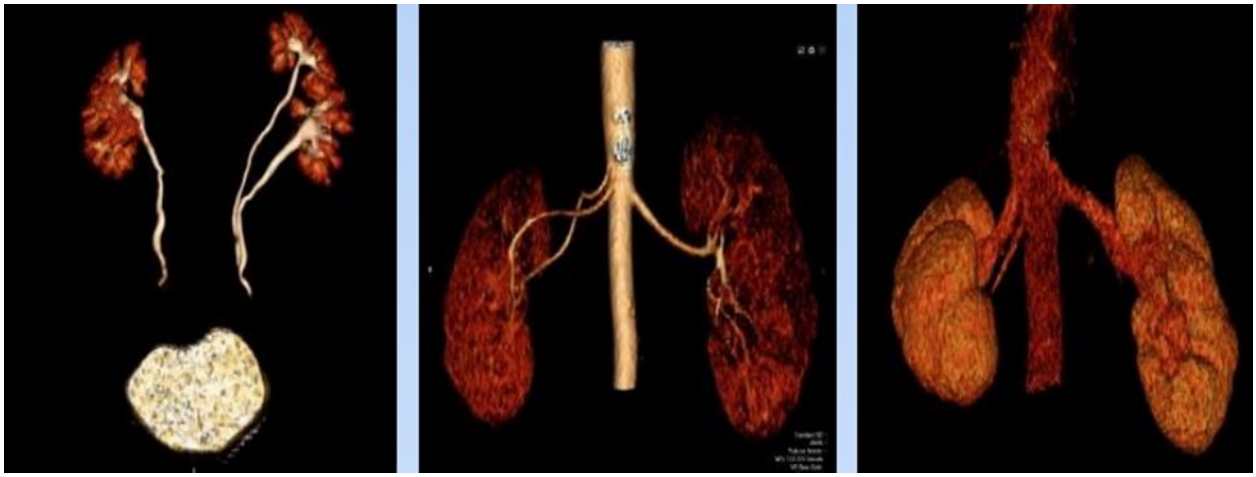

Figure 4: Three-dimensional volume rendered image showing duplex collecting system and variant renal vasculature.

Discussion:

Congenital kidney and urinary tract abnormalities affect 3–6 out of every 1000 live newborns [7]. Based on embryology, they may be divided into three categories: abnormalities of the collecting system [8], abnormalities of the development of the renal parenchyma, and abnormalities of the embryonic migration. With a prevalence of around 1%, duplex kidney is also a frequent anomaly [9]. The renal unit consisting of two pelvicalyceal systems is known as a duplex kidney [10]. A variety of complete or incomplete duplications of the collecting system are caused by the incomplete fusion of upper and lower kidney moieties, which is the hallmark of duplication, which is frequently categorized as either complete or partial [11], and occurs when two distinct ureteric buds emerge from a single Wolffian duct [12]. Partial ureteric duplication (Y-shaped ureter), incomplete ureteric duplication with ureters connecting near or in the bladder wall (V-shaped ureter), complete ureteric duplication with distinct ureteric orifices, and bifid renal pelvis are some of the possible presentations, depending on the degree of fusion [13]. Kidney and urinary tract congenital abnormalities belong to a family of diseases with various anatomical causes. Although duplex kidney is primarily asymptomatic, incidentally discovered, and clinically inconsequential, it can be linked to serious pathology, frequently with long-term morbidity, that is

specific to the renal moiety (lower moiety: VUR, renal scarring, and obstruction of the pyelo-ureteral junction; upper moiety: ectopic ureteric insertion, with or without a ureterocele and multicystic dysplastic moiety). Stone formation can be caused by a variety of anatomical defects. Urinary stasis raises the likelihood of stone formation and can be caused by renal abnormalities, polycystic kidneys, or blockages at the ureteropelvic junction or at any other level of the excretory system [14]. Urine calculi in people with duplex collecting systems are caused by partial urine stasis, while other variables unrelated to ureteral duplication may also play a role [15]. Complete duplex systems can be diagnosed with CT urography, MRI, and ultrasound. Duplex ureters are less likely to be detected by non-contrast CT scans, particularly if there is no prior clinical suspicion [16]. On a transverse CT scan, however, a faceless renal appearance without any vascular or collecting system marks typically indicates a duplex system [17]. Additional tests used to evaluate individuals with duplex systems include dimercaptosuccinic acid (DMSA) scans to evaluate function and scarring, and voiding cystourethrography (VCUG) to look for vesicoureteric reflux. Every kidney is normally fed by one renal vein that empties into the inferior vena cava (IVC) and one renal artery that emerges from the abdominal aorta. Renal arteries frequently vary in their origin, number, course, division, and penetration [18]. According to estimates, between 25% and 30% of people have extrarenal arteries that emerge from the aorta [19], and the prevalence varies depending on the community [20]. Compared to renal arteries, the number of renal veins varies less often; a study of numerous renal veins revealed a frequency of 21.6% on the right side [21].

Conclusion: This study proves that there is an association of renal artery variants with calculus formation in duplex collecting systems while there is no association of renal vein variants with calculus formation in duplex collecting systems.

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