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ANATOMICAL VARIATIONS OF THE UPPER URINARY TRACT: A RETROSPECTIVE STUDY OF 68 CASES

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ABSTRACT

Objective: To describe the clinical, imaging, and therapeutic profile of congenital upper urinary tract anomalies managed at a tertiary referral center.

Methods: This retrospective descriptive study included 68 patients admitted to the Department of Urology at Hassan II University Hospital, Fez, between January 2019 and December 2023.

Results: In our study, the age range most affected by upper urinary tract malformations was 21 to 40 years, with a female predominance (sex ratio: 0.87 M/F). Pyeloureteral junction syndrome was the most common anatomical variation, accounting for 79% of cases. Left urinary tract involvement was the most frequent, accounting for 46.7%. Lumbar pain was the main complaint (67.6%). Medical imaging played a crucial role in the diagnosis, enabling us to assess the morphological aspect of the malformations and their impact on the urinary tract, as well as to identify different congenital anomalies of the upper urinary tract for simplified classification. All patients diagnosed with congenital malformations of the urinary tract underwent personalized surgical treatment, with a generally favorable outcome

Conclusion: Diagnosis relies primarily on CT urography, supplemented by functional assessment in obstructive forms. Rigorous anatomical and functional characterization guides treatment selection.

Keywords: Upper urinary tract; Ureteropelvic junction; CT urography; Congenital anomalies; Pyeloplasty.

1 INTRODUCTION

Congenital anomalies of the upper urinary tract comprise malformations of the renal pelvis and ureter that may impair urinary drainage. Their clinical presentation ranges from incidental detection to obstruction complicated by infection, urolithiasis, or loss of renal function [1,2]. In adults, these anomalies may remain unrecognized until flank pain or a complication develops. Imaging should delineate the anatomy, assess the consequences of obstruction, and, when required, determine split renal function. This study describes the clinical, morphological, functional, and therapeutic characteristics of 68 patients managed in a university urology department.

2 MATERIALS AND METHODS

This retrospective descriptive study was conducted in the Department of Urology at Hassan II University Hospital, Fez, from January 1, 2019, to December 31, 2023. Patients hospitalized for a congenital variation of the upper urinary tract were included. Acquired abnormalities and records without usable follow-up data were excluded. Data were obtained from medical records and operative reports. The variables assessed were age, sex, side involved, circumstances of diagnosis, renal function, urine culture findings, morphological and functional investigations, type of anomaly, complications, and treatment. Descriptive analysis was performed using Microsoft Excel; categorical variables are reported as counts and percentages, and quantitative variables as means and ranges. The data were anonymized as part of academic work approved by the thesis committee.

3 RESULTS

The mean age of the 68 patients was 46 years (range, 17-73 years); patients aged 21-40 years accounted for 55% of the cohort. Thirty-six patients were women (52.9%) and 32 were men (47.1%). Involvement was left-sided in 32 cases (47.1%), right-sided in 30 (44.1%), and bilateral in 6 (8.8%). Renal colic was the most common presentation (67.6%), followed by acute pyelonephritis (11.8%) and incidental detection (8.4%); several manifestations could coexist. Overall renal function was preserved in 66 patients and impaired in 2. Urine findings were sterile in 49 patients, showed sterile leukocyturia in 12, and yielded a positive culture in 7, most commonly Escherichia coli, Klebsiella pneumoniae, or Enterococcus faecalis.

Table 1: Main Characteristics of the Cohort (N = 68)

Characteristic	Result	Anomaly	n (%)
Mean age (range)	46 years (17-73)	Ureteropelvic junction obstruction	54 (79.4)
Women / men	36 / 32	Ureterocele	5 (7.4)
Left / right / bilateral	32 / 30 / 6	Primary megaureter	3 (4.4)
CT urography	63 (92.6%)	Ureteral stricture	2 (2.9)
Urinary stasis calculi	15 cases	Duplex collecting system	2 (2.9)
Acute pyelonephritis	8 cases	VUR / retrocaval ureter	1 / 1 (1.5 each)

Table 1Main Characteristics of the Cohort (N = 68)

CT urography was the primary morphological imaging modality (63/68; 92.6%), followed by intravenous urography (13 cases), ultrasonography (11), dynamic renal scintigraphy (7), and magnetic resonance imaging (1). Among the 63 CT urograms available for detailed analysis, pelvicalyceal dilatation was reported in 82.25% of cases and ureteropelvicalyceal dilatation in 16.12%. Parenchymal thinning was observed in 37.09%, delayed nephrographic or excretory function in 30.67%, and associated urolithiasis in 22.58%. Dynamic renal scintigraphy showed a mean differential renal function of 43.5% (range, 6-81%). Collecting-system dilatation was present in all patients; 15 had urinary stasis calculi, 8 had acute pyelonephritis, 1 had pyonephrosis complicated by an abscess, and 1 had a nonfunctioning kidney.

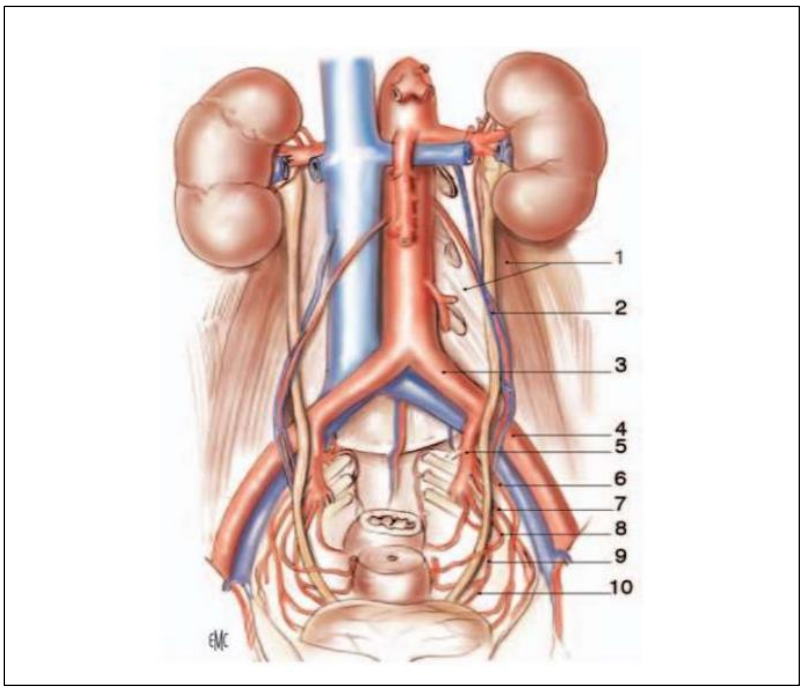
Ureteropelvic junction obstruction (UPJO) was the most common anomaly (54/68; 79.4%). Treatment comprised 46 open pyeloplasty, 3 laparoscopic pyeloplasty, 2 endopyelotomies, and 3 nephrectomies. The five ureteroceles were treated by four Politano-Leadbetter ureteral reimplantations and one endoscopic meatotomy. The three primary megaureters and the case of vesicoureteral reflux were managed by ureterovesical reimplantation; the two duplex collecting systems were treated by heminephrectomy with ureterectomy. Ureteral strictures were managed by Lich-Gregoir reimplantation in one case and double-J stenting in the other. The retrocaval ureter was corrected by resection and ureteroureteral anastomosis combined with treatment of concomitant UPJO.

4 DISCUSSION

The upper urinary tract comprises the intrarenal collecting system—including the minor and major calyces and the renal pelvis—and the ureter. Urine passes from the renal papillae into the minor calyces, which converge into the major calyces and subsequently drain into the renal pelvis. The ureteropelvic junction marks the transition from the renal pelvis to the ureter but does not constitute a distinct anatomical sphincter. Urinary drainage at this level may nevertheless be compromised by intrinsic abnormalities, high ureteral insertion, or lower-pole crossing vessels. Coordinated smooth-muscle peristalsis propels urine through the ureter toward the bladder, while its oblique intramural course provides an antireflux mechanism. Consequently, congenital variations affecting these structures may impair urinary drainage and promote urinary tract dilatation, infection, calculus formation, and progressive renal functional impairment (Figure 1).

In the present hospital-based series, UPJO was by far the most common congenital upper urinary tract anomaly diagnosed in adulthood. The mean age of 46 years was higher than that reported in other adult series, particularly those by Joual and Kpatcha [3,4]. This difference may reflect delayed diagnosis, variations in referral patterns, or the inclusion of several types of congenital anomaly. The slight female predominance and the nearly equal distribution of right- and left-sided involvement preclude firm epidemiological conclusions.

Renal colic was the most common presenting manifestation, consistent with the intermittent nature of some forms of urinary obstruction. Conversely, infection, urinary stasis calculi, and renal functional impairment represent recognized consequences of inadequate or prolonged urinary drainage. Several manifestations could coexist in the same patient.



1. Psoas major muscle covered by the iliac fascia, with its attachment arches to the lumbar spine (transverse processes of L1, L2, and L3 visible); 2. Gonadal vessels; 3. Left common iliac artery; 4. Left external iliac artery; 5. Left internal iliac artery; 6. Left umbilical artery; 7. Left obturator artery; 8. Left uterine artery; 9. Vaginal artery; 10. Inferior vesical artery.

Figure 1: Extraperitoneal and arterial relations of the ureters in the female (anterior view) [5]

CT urography was the principal morphological imaging modality in this series and was performed in 92.6% of patients. It provides a detailed assessment of the collecting system, renal parenchyma, associated calculi, and relevant vascular relationships. CT angiography and multiplanar reconstructions may also identify lower-pole crossing vessels at the ureteropelvic junction, thereby improving anatomical characterization and assisting surgical planning [6,7]. Dynamic renal scintigraphy provides complementary functional information by assessing urinary drainage and quantifying split renal function, particularly when deciding between renal-preserving surgery and nephrectomy [8]. However, scintigraphy was performed in only seven patients in the present series, probably reflecting its selective use in patients with suspected functional impairment. This limited sample precluded a meaningful analysis of the relationship between morphological findings, renal function, and treatment selection.

Anderson-Hynes dismembered pyeloplasty remains the standard renal-preserving treatment for UPJO. The predominance of open pyeloplasty in this series likely reflects local surgical practices, technical resources, and expertise available during the study period. Previous studies have reported favorable outcomes with both open and laparoscopic approaches, although laparoscopy generally offers lower incisional morbidity and faster postoperative recovery at the cost of greater technical complexity [9-11]. Nephrectomy was reserved for kidneys with severely impaired function. Nevertheless, the absence of standardized postoperative clinical and functional follow-up prevented the assessment of treatment success rates and comparison of outcomes between surgical techniques.

Management of the other congenital anomalies should be individualized according to anatomical characteristics, the degree of obstruction or reflux, renal function, and associated complications. Primary obstructive megaureter is uncommon in adults; ureteral reimplantation, with or without ureteral tailoring, depends on the severity of obstruction, the presence of reflux, and ureteral caliber [12,13]. Duplex collecting systems require accurate anatomical and functional assessment of each renal moiety before conservative or ablative surgery [14]. Treatment of ureterocele may involve endoscopic incision or reconstructive surgery depending on its location, associated obstruction or reflux, and effects on renal function [15]. In patients with vesicoureteral reflux, the radiological grade, recurrence of urinary tract infections, and presence of renal damage are the main factors guiding therapeutic decisions [16].

This study has several limitations, including its retrospective and single-center design, the small size of the individual anomaly subgroups, heterogeneity in the diagnostic investigations performed, and the absence of a standardized clinical and functional follow-up protocol. These limitations restrict the generalizability of the findings and prevent a reliable comparison of therapeutic outcomes. Prospective multicenter studies using standardized radiological and functional criteria, together with medium- and long-term postoperative follow-up, are needed to better define the relationship between anatomical phenotype, treatment selection, and clinical outcomes.

5 CONCLUSION

Congenital variations of the upper urinary tract are often diagnosed following pain or a complication. UPJO was by far the predominant anomaly in this series. CT urography provided morphological characterization, whereas renal scintigraphy offered targeted functional information. Treatment should be individualized according to anatomy, clinical consequences, renal function, and available technical resources.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no competing interests.

Statement of informed consent

Informed consent was obtained from all patients or their legal guardians, as applicable, for the publication of their anonymized clinical data and any accompanying images.

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