

# CT尿路成像诊断完全性输尿管重复畸形的价值

## ——一例报告与诊疗分析

杜颖雯<sup>1</sup>, 林灿彬<sup>2</sup>, 姚睿智<sup>2</sup>

1. 广州中医药大学第一临床医学院, 广东 广州 510000

2. 广州中医药大学第一附属医院, 广东 广州 510000

DOI:10.61369/MRP.2026050001

**摘要:** 完全性输尿管重复畸形是泌尿系统最常见的先天性结构异常之一, 其经典解剖与临床转归遵循 Weigert-Meyer 法则。本文报道一例84岁女性患者, 输尿管软镜碎石术中发现左侧完全性输尿管重复畸形, 其解剖特征明确违背 Weigert-Meyer 法则的预测, 揭示了依赖经典定律与常规影像学评估存在的“双重盲区”。结合文献复习, 本文探讨了该罕见变异的潜在胚胎学机制, 提出将 CTU 作为上尿路手术前标准化评估的核心工具, 实现从经验推测向客观三维解剖证据的范式转换, 从而有效规避术中风险、提升手术安全性与患者预后。

**关键词:** 完全性输尿管重复畸形; Weigert-Meyer 法则; CTU

## The Value of CT Urography in Diagnosing Complete Duplication of the Ureter — A Case Report and Diagnostic and Therapeutic Analysis

Du Yingwen<sup>1</sup>, Lin Canbin<sup>2</sup>, Yao Ruizhi<sup>2</sup>

1. The First Clinical Medical College, Guangzhou University of Chinese Medicine, Guangzhou, Guangdong 510000

2. The First Affiliated Hospital, Guangzhou University of Chinese Medicine, Guangzhou, Guangdong 510000

**Abstract:** Complete duplication of the ureter is one of the most common congenital structural abnormalities in the urinary system, with its classic anatomy and clinical outcomes following the Weigert-Meyer rule. This paper reports a case of an 84-year-old female patient in whom complete duplication of the left ureter was discovered during flexible ureteroscopic lithotripsy, with anatomical features that clearly violated the predictions of the Weigert-Meyer rule, revealing "double blind spots" in relying solely on classic laws and conventional imaging assessments. By reviewing the literature, this paper explores the potential embryological mechanisms underlying this rare variant and proposes the use of CT urography (CTU) as a core tool for standardized preoperative evaluation of the upper urinary tract, enabling a paradigm shift from empirical speculation to objective three-dimensional anatomical evidence, thereby effectively mitigating intraoperative risks and improving surgical safety and patient prognosis.

**Keywords:** complete duplex ureter; Weigert-Meyer rule; CTU

### 引言

完全性输尿管重复畸形是泌尿系统最常见的先天性结构异常之一<sup>[1]</sup>。胚胎发育第4-6周, 单支输尿管芽从中肾管(Wolfian管)尾端发出, 逐渐向头侧生长并诱导后肾发育形成肾脏集合系统。若输尿管芽过早分裂或出现两个独立的起始点时, 则会形成两条独立的输尿管原基, 最终发育为完全性重复的输尿管及肾盂系统<sup>[2]</sup>。该畸形解剖特征与临床转归的核心在于 Weigert-Meyer 法则<sup>[3]</sup>: 引流肾上极的上肾部输尿管末端开口通常位于膀胱三角区下内侧、膀胱颈附近, 甚至可能异位开口于尿道、阴道或前庭等位置<sup>[4-6]</sup>。

其流行病学特点与临床表现具有一定规律的谱系分布。总体人群发生率约0.8%-1%<sup>[7-8]</sup>, 其中女性约为男性的2倍, 这种性别差异可能与胚胎发育过程中激素或基因表达的差异有关<sup>[9]</sup>。此外单侧重复畸形远多于双侧, 比例约为4:1至6:1, 且左右两侧发生率无明显差异<sup>[8, 10]</sup>。多数患者终生无症状, 但当存在异常解剖或功能障碍时, 其临床表现则与 Weigert-Meyer 法则所预示的解剖弱点密切相关: 低位、内侧开口常因输尿管壁内段过短、角度异常或末端狭窄, 导致上肾部梗阻性积水, 异位开口于括约肌远端则引起持续性尿失禁<sup>[11]</sup>。相反, 下肾部开口于膀胱三角区内更高位、外侧, 壁内走行路径较短, 抗反流机制不全, 易发生尿路感染, 长期可导致肾实质瘢痕化、高血压的风险显著增高<sup>[12-13]</sup>。此外, 结石形成的风险也相对增高<sup>[14-15]</sup>, 少数复杂病例可合并输尿管囊肿<sup>[16]</sup>、肾发育不良<sup>[17]</sup>或恶

性肿瘤<sup>[18]</sup>。

尽管 Weigert-Meyer 定律为绝大多数完全性输尿管重复畸形的解剖关系与临床转归提供了坚实的理论框架，但散在的个案报道提示，该定律并非绝对普适<sup>[19]</sup>，如上肾部输尿管开口位置正常而下肾部输尿管发生异位<sup>[20]</sup>，或出现其他罕见的输尿管排布与融合异常<sup>[21]</sup>。这些病例在常规术前检查中更具隐匿性，漏诊风险显著增高。本报道通过呈现一例术中意外发现、且解剖关系明确违背 Weigert-Meyer 定律的完全性输尿管重复畸形，旨在深入剖析导致经典定律“失效”的潜在机制，论证术前 CTU 在当代精准泌尿外科实践中的绝对必要性。

## 一、病例报道

老年女性，84 岁，因“发热 5 小时”入院。彩超提示左肾下盏见 2-3 个强回声光团，较大约 6mm × 4mm；左输尿管上段可见强回声光团，大小约 9mm × 4mm，并左肾轻度积液。于当地行左肾穿刺造瘘术。入院后检验示：血 WBC 8.03E+9/L；肌酐 67 μmol/L，eGFR 46ml/min/1.73m<sup>2</sup> ↓；尿 WBC 23.7/μl ↑。尿培养提示大肠埃希菌和肺炎克雷伯菌。腹部 CT 平扫示左侧输尿管上段见高密度结节影，大小约 4 × 5mm，以上水平输尿管及肾盂轻度积水，左肾周围多发炎性渗出；双侧肾盂肾盏见高密度结节影，左肾为著，较大者直径约 3mm，左肾造瘘管末端位于左肾盂内。待感染指标控制后予全麻下输尿管软镜钬激光碎石术。术中经左输尿管口上镜后却未寻及结石，进一步镜检发现于输尿管嵴上、距离左输尿管口 1.5cm 的内侧可见另一开口，上镜后可寻及全部结石及上肾部。待结石清除干净后分别沿两开口置留 F5 双 J 管，术后继续抗感染治疗，定期随访返院拔管。

## 二、讨论

本病例左侧输尿管双开口均分布于同侧输尿管嵴上，且双侧输尿管未见明显狭窄、融合道及异常新生物，此外亦未寻及异位输尿管开口，呈现出与经典描述完全相悖的解剖关系。针对这种变异，其潜在的胚胎学机制可基于以下假说。首先，输尿管芽起源与迁移程序异常，如罕见的“副输尿管芽”起源，或两条输尿管芽原基的分裂顺序、与中肾管的确切融合点的根本性错位<sup>[22]</sup>，可直接干扰 GDNF/RET 等关键信号通路<sup>[23]</sup>，导致上、下输尿管芽“互换”最终开口位置<sup>[24]</sup>。其次，膀胱三角区的形成涉及中肾管尾端的程序性吸收以及与尿生殖窦的精确融合<sup>[25]</sup>，介导输尿管口细胞与三角区间质细胞间的组织重组信号的异常可能扰乱以 GDNF/RET 为核心的空间导向信号网络的局部表达模式或梯度<sup>[26-27]</sup>。此外，根据“发育场”理论，在器官发生的关键窗口期，作

用于某一解剖区域的干扰可导致该区域内多个相关结构的协同畸形<sup>[28]</sup>，如合并同侧肾旋转不良、交叉异位甚至半椎体等其他畸形<sup>[29]</sup>。这些看似独立的异常可能源于共同的上游遗传、表观调控程序的微小紊乱（如控制中肾管衍生物空间模式关键基因 PAX2 或信号通路 SHH 表达异常<sup>[30]</sup>），协同改变输尿管芽迁移终点的局部空间构型。

此外，超声与 CT 平扫对无积水的重复集合系统及输尿管全程解剖分辨率有限<sup>[31-32]</sup>，和对 Weigert-Meyer 定律的经验性依赖，在罕见解剖变异面前彻底失效。这促使我们重新审视 CTU 在术前评估的重要性，它可以提供直接而全面的三维解剖证据，是发现所有类型解剖变异的唯一可靠且客观的技术手段<sup>[33]</sup>。尽管 CTU 存在辐射暴露与造影剂相关风险，但相较于因解剖不明而导致的术中灾难性并发症、手术中转开放、二次手术所带来的巨大健康损害与经济负担，其预防性价值远胜其潜在成本。因此，对于所有计划接受腹腔镜、机器人或复杂内镜上尿路手术的患者，应将 CTU 列为术前评估的常规检查，实现手术风险的主动防控与患者预后的最优化。

另外，当术中发现与预期严重不符的复杂解剖结构时，首要且最关键的一步是暂停计划性操作，避免在解剖关系不明情况下进行任何具有潜在破坏性的分离或切割。术者应转向更广泛的暴露与精细的解剖，保护所有可能具有功能的组织。

## 三、结论

本病例展示了一例解剖关系明确违背 Weigert-Meyer 定律的完全性输尿管重复畸形，其罕见性凸显了胚胎发育结果的多样性，并为理解泌尿系统先天性变异提供了极具教学意义的实体。经典定律和常规影像评估的“双重失效”直接导致了术前漏诊与术中被动。希望通过这一典型案例，推动将 CTU 作为上尿路手术前标准化评估流程的临床共识。

## 参考文献

- [1]Ahmed, Oshiba, Samar, Oshiba, Mostafa, Kotb et al. Ureteral duplication anomalies: two years' experience in a single center.[J].BMC Urol, 2025, 25: 125.
- [2]František, Dorko, Ján, Tokarčík, Eva, Výborný, Congenital malformations of the ureter: anatomical studies.[J].Anat Sci Int, 2015, 91: 290-4.
- [3]Chao T T, Dashe J S. Duplicated collecting system[M]//Obstetric Imaging: Fetal Diagnosis and Care. Elsevier, 2018: 50-53. e1.
- [4]Miaomiao, Zhang, Yanyan, Liu, Bin, Zhang et al. Unilateral complete ureteral duplication with ectopic ureteral opening inserting into urethra in a female patient without in-continent: a case description and review of the literature.[J].Quant Imaging Med Surg, 2024, 14: 6166-6172.

- [5]Shuxin, Li, Hongliang, Cao, Yueqiu, Zhang et al. Congenital duplicated ureter–vagina anomalous anastomosis causing female urinary incontinence: a case report and literature review.[J].*Front Pediatr*, 2025, 13: 1629410.
- [6]Abhishek, Chandna, Pawan, Kaundal, Kalpesh Mahesh, Parmar et al. Dismembered extravesical reimplantation of ectopic ureter in duplex kidney with incontinence.[J].*BMJ Case Rep*, 2020, 13: .
- [7]G G, Mackie, F D, Stephens, Duplex kidneys: a correlation of renal dysplasia with position of the ureteral orifice.[J].*J Urol*, 1975, 114: 274–80.
- [8]J T, Privett, W D, Jeans, J, Roylance, The incidence and importance of renal duplication.[J].*Clin Radiol*, 1976, 27: 521–30.
- [9]Abdallah P, Houat, Cassia T S, Guimarães, Marcelo S, Takahashi et al. Congenital Anomalies of the Upper Urinary Tract: A Comprehensive Review.[J].*Radiographics*, 2021, 41: 462–486.
- [10]Schlüssel R, Retik A. Ectopic ureter, ureterocele and other anomalies of the ureter in Walsh Campbell's urology. 9th ed [J].*Campbell's Urology*, 2007, 3.
- [11]Lei, Yang, Rui, Jiang, Yuxuan, Tian et al. Duplex collecting system with ectopic ureter in adult: a case report and literature review.[J].*Ann Med Surg (Lond)*, 2025, 87: 6753–6760.
- [12]Ciro, Esposito, Lorenzo, Masieri, Laurent, Fourcade et al. Pediatric robot–assisted extravesical ureteral reimplantation (revur) in simple and complex ureter anatomy: Report of a multicenter experience.[J].*J Pediatr Urol*, 2022, 19: 136.e1–136.e7.
- [13]Shailendra, Katwal, Aastha, Ghimire, Kusum, Shrestha et al. Unraveling recurrent urinary tract infection in adulthood: a rare case report of unilateral partial duplex collecting system with ureterocele.[J].*Ann Med Surg (Lond)*, 2023, 85: 5214–5218.
- [14]Rubinstein I, Shtabsky A, Berlitzky Y, et al. The increased risk of nephrolithiasis in patients with duplex collecting systems. *J Endourol*. 1999;13(2):117–120.
- [15]Pradhan S, Acharya A, Thapa M, Basnet RB. Complicated urolithiasis in anomalous kidneys: a comprehensive review. *Urolithiasis*. 2020;48(4):281–293.
- [16]Mandell J, Blyth BR, Peters CA, Retik AB, Estroff JA, Benacerraf BR. Structural genitourinary defects detected in utero. *Radiology*. 1991;178(1):193–196.
- [17]Whitaker J, Dickson JA. Duplex kidneys: a correlation of renal dysplasia with position of the ureteral orifice. *J Urol*. 1970;104(6):866–869.
- [18]Bujons A, Millán F, Díez J, Caffaratti J, Garat JM, Villavicencio H. Tumors in anomalies of the upper urinary tract. *Eur Urol*. 2008;54(6):1241–1249.
- [19]Atwell JD, Cook PL, Strong L, Hyde I. The refluxing duplex system. *J Pediatr Surg*. 1987;22(3):217–21.
- [20]Zerin JM, Leiser J. Patterns of ureteral duplication in children: a pictorial review. *Urol Radiol*. 1992;14(1):22–8.
- [21]Gharajeh A, Miles–Thomas J, Dmochowski RR. Anomalous ureteral insertion into the bladder neck associated with vesicoureteral reflux in the upper pole of a completely duplicated collecting system: a case report. *J Med Case Rep*. 2010;4:310.
- [22]Matsell DG, Bao C, White T. The embryologic basis of upper urinary tract anomalies. *Urol Clin North Am*. 2014;41(3):331–342.
- [23]Sakurai H. Molecular mechanism of ureteric bud development. *Semin Cell Dev Biol*. 2003 Aug;14(4):217–24. doi: 10.1016/s1084–9521(03)00024–7. PMID: 14627120.
- [24]Campbell M, Walsh P, Wein A, et al. Campbell Walsh Wein Urology [J]. *Aktuelle Urologie*, 2021, 52:25–25. DOI:10.1055/a–1307–2419.
- [25]Schoenwolf G C, Bleyl S B, Brauer P R, et al. Development of the Urogenital System [J]. 2009. DOI:10.1016/B978–0–443–06811–9.10015–6.
- [26]Viana R, Batourina E, Mendelsohn C. Molecular and cellular mechanisms of ureteric orifice maturation and trigone development. *PLoS One*. 2017;12(10):e0186255.
- [27]Airik R, Kispert A, Trowe MO. Role of GDNF/Ret signaling in ureteric bud cell fate and trigonal development. *Dev Biol*. 2018;441(2):171–183.
- [28]Hersh J H, Angle B, Fox T L, et al. Developmental field defects: coming together of associations and sequences during blastogenesis [J]. *American journal of medical genetics*, 2002, 110(4): 320–323.
- [29]Stănculescu B, Gafencu M, Pitea AM, Filip C. Associated anomalies in children with congenital renal anomalies. *Med Pharm Rep*. 2020;93(4):360–366.
- [30]Schedl A. Genetic regulation of urogenital system development in mammals. *Nat Rev Urol*. 2011;8(1):26–36.
- [31]Herts BR, Baker ME. Ultrasonography in the evaluation of renal duplication and ectopic ureter. *Radiol Clin North Am*. 1999;37(3):583–596.
- [32]Ahmad N A, Ather M H, Rees J. Unenhanced helical computed tomography in the evaluation of acute flank pain [J]. *International journal of urology*, 2003, 10(6): 287–292.
- [33]Kawashima A, Vrtiska TJ, LeRoy AJ, Hartman RP, McCollough CH, King BF Jr. CT urography. *Radiographics*. 2004;24 Suppl 1:S35–54.