ORIGINAL ARTICLE | Abdominal Imaging

Radiological Characterization of Rare Congenital Malformations of the Mesonephric Duct: Imaging and Developmental Considerations

Dimitrios Kourdakis MD, Alexandros Tsitouridis MD, Elena Hadjichristou MD, Georgios Ursof MD, Eleni Makridou MD, Maria-Michailia Vogiatzi MD
Agios Dimitrios General Hospital, Department of Radiology
Thessaloniki, Greece, Elenis Zografou 2, 54634

SUBMISSION: 16/10/2025 | ACCEPTANCE: 05/11/2025

STRUCTURED ABSTRACT

Purpose: To describe and analyze congenital anomalies of the mesonephric (Wolffian) duct persistence identified in pediatric patients, including one previously undescribed anomaly, through detailed radiological evaluation and embryological interpretation. These may present with non-specific symptoms or be incidentally discovered.

Material and Methods: Retrospective research was conducted over a 5-year period. Inclusion criteria required availability of complete clinical and imaging records and histopathological confirmation of mesonephric duct remnants after surgical excision. Clinical image and radiological findings were analyzed in conjunction with pathophysiology mechanisms and em-

KEY WORDS
Congenital Abnormalities, Embryology, Mesonephric duct, Wolffian duct, Urogenital Abnormalities

CORRESPONDING AUTHOR, GUARANTOR
Dimitrios Kourdakis MD, Agios Dimitrios General Hospital, Department of Radiology - Thessaloniki, Greece, Elenis Zografou 2, 54634
Email: dimitriskourd1@gmail.com
Tel: +306980385351

bryological development to understand the origin and implications of the anomalies.

Results: Three pediatric patients met the initial screening criteria, but one was excluded due to incomplete clinical records. From the remaining two cases, the first case involved a novel congenital variant not previously reported in the literature, presenting as isolated mesonephric duct persistence along its entire length without associated anomalies. The second case demonstrated a rare mesonephric anomaly characterized by incomplete metanephric development coexisting with mesonephric duct persistence.

Conclusion: Congenital anomalies of the mesonephric duct are rare and often extremely challenging to diagnose. Radiologic imaging, particularly when interpreted in the context of embryological development, plays a key role in their identification and classification. The mesonephric duct anomalies presented in this research article expand the known spectrum of mesonephric malformations and may contribute to improved diagnostic recognition in pediatric urogenital disorders as well as future classification systems.

Introduction

Congenital anomalies arising from the persistence of the mesonephric (Wolffian) duct represent a rare but clinically significant group of developmental disorders affecting the genitourinary system. The mesonephric ducts in the intermedia stage of kidney embryogenesis, play a critical role in the formation of the ureters, trigone of the bladder, as well as male reproductive structure. In females, these ducts typically regress due to the absence of testosterone and Müllerian-inhibiting factor. However, incomplete or aberrant regression may result in the retention of ductal remnants, which can present in various anatomical locations and forms. Although these remnants are often asymptomatic and incidentally discovered, these sometimes can lead to clinical problems such as pelvic masses, obstruction, or even malignant transformation in rare cases.[1]

Embryology

The urogenital system arises from the intermediate mesoderm during the 4th week of gestation, giving rise to the nephrogenic cord. Three successive kidneys embryonic stages form rostrally and progress caudally over a few weeks in the nephrogenic cord: the pronephros, mesonephros, and metanephros. The pronephros appears in the cervical region and consists of the pronephric duct and the nephrotomes. It is a nonfunctional, transient structure that regresses by 25th day. At the end of the 4th week, as the primary nephric ducts extend caudally, the intermediate mesoderm condenses to form the mesonephros at the level of thoracolumbar region. The mesonephros is functional, produces urine and drains into the mesonephric duct. Mesonephros consists of numerous mesonephric tubules, which connect laterally to the mesonephric duct and medially to the developing glomeruli, facilitating temporary filtration and excretion (during embryonic life). During the 5th week, the mesonephric duct progresses caudally and fuses with the cloaca, thus induces the sacral intermediate mesoderm to form an aggregate known as the metanephric blastema at the level of the sacral region. The metanephric blastema secrets a protein that stimulates a lateral outgrowth in the mesonephric duct known as the ureteric bud, invading the metanephric blastema and initiates a series of reciprocal inductive interactions.[2] These interactions drive branching morphogenesis of the ureteric bud to form the ureter, renal pelvis, major and minor calyces, and the collecting ducts, while the metanephric mesenchyme differentiates into the nephron components. At this stage, the kidneys are located close to each other in the sacral region, with the hila facing anterior in the pelvis. As development proceeds, the kidneys are drawn apart and ascend from the pelvic region to their final lumbar position by the 9th week, rotating medially about 90 degrees so that the hila face anteromedially. The cranial to the ureteric bud portion of the mesonephric duct persists in males, giving rise to vas deferens, epididymis and seminal vesicles. The common ejaculatory ducts created from the caudal (to the ureteric bud) part. In females due to the absence of testosterone and Müllerian-inhibiting factor this portion of mesonephric duct regresses. The regression of embryonic genital ducts leaves behind remnants known as vestigial structures. These persist as an appendix of epididymis and paradidymis in males and as appendix vesiculosa, epoophoron, paraoophoron and Gartner's ducts in females (cranial to caudal).[3] These remnants rarely can cause pathologies such as cysts formation, mesonephric hyperplasia, mesonephric carcinoma and Adnexal Tumors of probable Wolffian origin (FATWO).[1],[4]

Material and Methods

Over a period of 5 years, 2 patients were identified and investigated for abnormal mesonephric duct remnants at our institution. Inclusion criteria included: (1) availability of a complete clinical and imaging record and (2) histopathological confirmation of mesonephric duct remnants following surgical excision. Patients' ages were 10- and 12-year-old. The 2 patients underwent Computed Tomography (CT), ultrasound and Magnetic Resonance Imaging (MRI). CT scans were obtained with a Siemens CT scanner device with slice thickness, 5 mm; pitch, 2; reconstruction interval, 5mm. Images were obtained after contrast agent administration during portal phase (60-70 seconds after injection) and in the equilibrium phase (5 minutes after injection). A bolus injection of 120 mL (3-4ml/sec) of non-ionic contrast medium was given.

MRI scans were obtained with a Siemens 1T scanner (Siemens Expert Plus, Erlangen, Germany). Before contrast administration, axial and coronal HASTE T2-weighted images (TR, 6 ms; TE, 60 ms) were obtained with a slice thickness of 8 mm; FOV, 340–400 mm depending on patient's size; and matrix, 256 x 192. After administration of 10 mL of contrast agent axial FLASH T1-weighted images (TR, 11 ms; TE, 4.2 ms) were obtained with a slice thickness of 8 mm; FOV, 340–400 mm, matrix, 256 x 192.

Results

Over a 5-year period, two pediatric patients who fulfilled the predefined inclusion criteria were identified. One patient was excluded due to incomplete clinical record (part of the examinations were conducted in other hospitals and were unable to be retrieved). We describe the two cases of mesonephric duct persistence, one of them associated with anomalies of metanephros.

Case 1

A 12-year-old girl presented with low abdominal pain. Physical examination and laboratory tests were unremarkable. Ultrasound evaluation showed a right dilated ureter-like structure extending from above the right kidney to the genitalia. Both kidneys appeared normal and no other abnormality was detected. MRI was conducted for further assessment of the tubulocystic lesion. MRI revealed a non-communicating, tubulocystic, well-defined, dilated structure extending above the level of the right kidney reaching the right-side vesicoureteric junction in a serpentine like path. **(Fig. 1)**, **(Fig. 2)**. With the right kidney, right ureter, and genitalia appearing normal, our differential diagnosis was further refined. Taking into consideration the anatomy and embryology of the structure in combination with the absence of other coexisting abnormalities, the di-

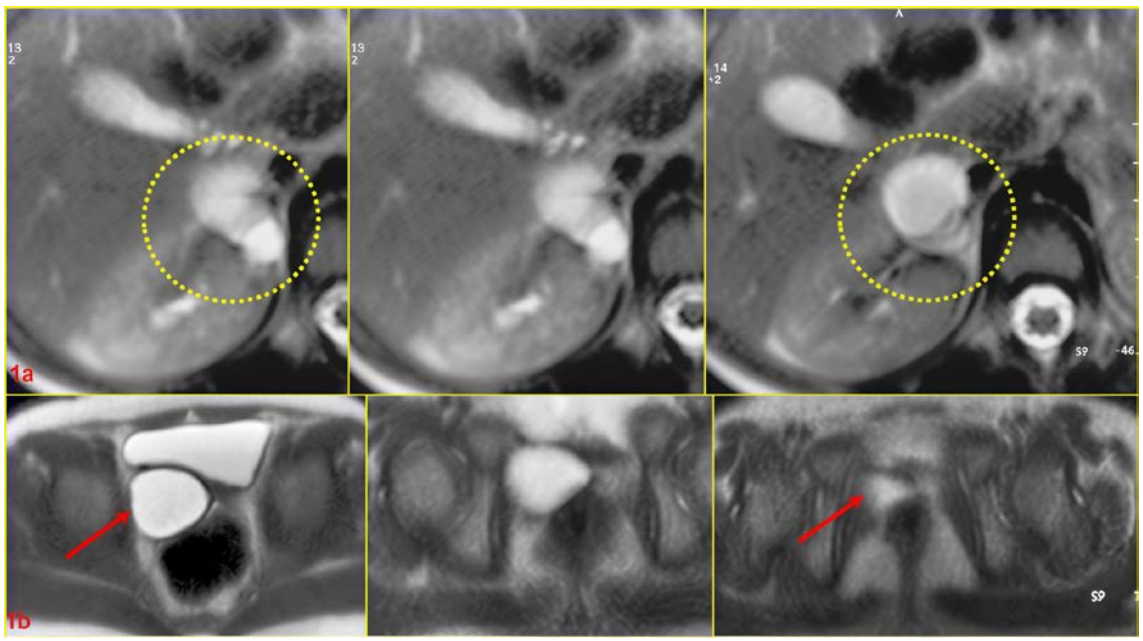

Figure 1 a-b *Axial T2-weighted images (a), at the level of the right kidney (Circle), (b), at the level of the urinary bladder (Arrow) which show a dilated remnant of the mesonephric duct*

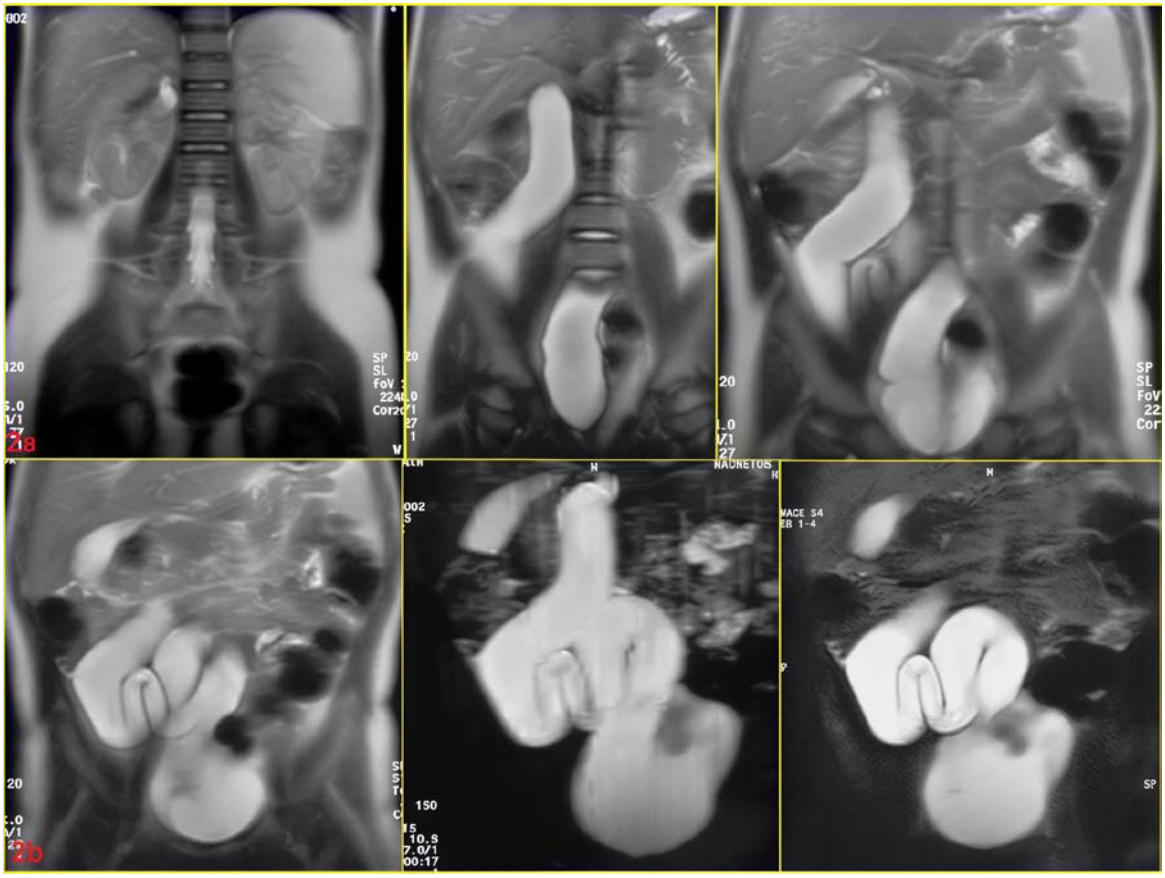

Figure 2 a-b *Coronal T2-weighted images which show the extension of the dilated mesonephric duct. The right kidney was normal in the orthotopic position*

agnosis of mesonephric duct persistence was made and the patient was admitted to pediatric surgeons for excision of the lesion.

Case 2

A 10-year old boy presented with low abdominal pain, especially on the right lower quadrant. Physical examination and laboratory tests were unremarkable. Ultrasound revealed a left hypertrophied kidney, raising our concerns for right ectopic kidney or right kidney absence. After further evaluation, right kidney could not be identified and furthermore, a polypoid-like mass was observed inserting in the right lateral wall of the urinary bladder. **(Fig. 3)** CT demonstrated a tubulocystic mass next to the right lateral wall of the urinary bladder. **(Fig. 4)** MRI confirmed the dysplastic ectopic kidney in the right pelvic region and a tubulocystic structure communicating with the urinary bladder in the vesicoureteric junction. **(Fig. 5)** The diagnosis of incomplete development of the metanephros and persistence of the mesonephric duct was made and subsequently confirmed histologically following surgical excision.

Discussion

Abnormal persistence of mesonephric duct structures can present with a variety of morphologic patterns depending on the extent of duct persisting, the exact anatomic location and the sex of the individual. Understanding these complex entities requires both an anatomical and an embryological framework. These anomalies usually are associated with renal agenesis or dysplasia. Coleman et al.[5] made a study of 19 patients with tubulocystic abn ormalities of the mesonephric duct structures in association with multicystic dysplastic kidney (MCDK) or renal agenesis. They classified their patients into three groups according to the anatomy (location of the anomalies):

- **Type 1:** remnants of the mesonephric duct corresponding to ureteric bud structures in orthotopic position (1a: orthotopic ureterocele and 1b: ureter-

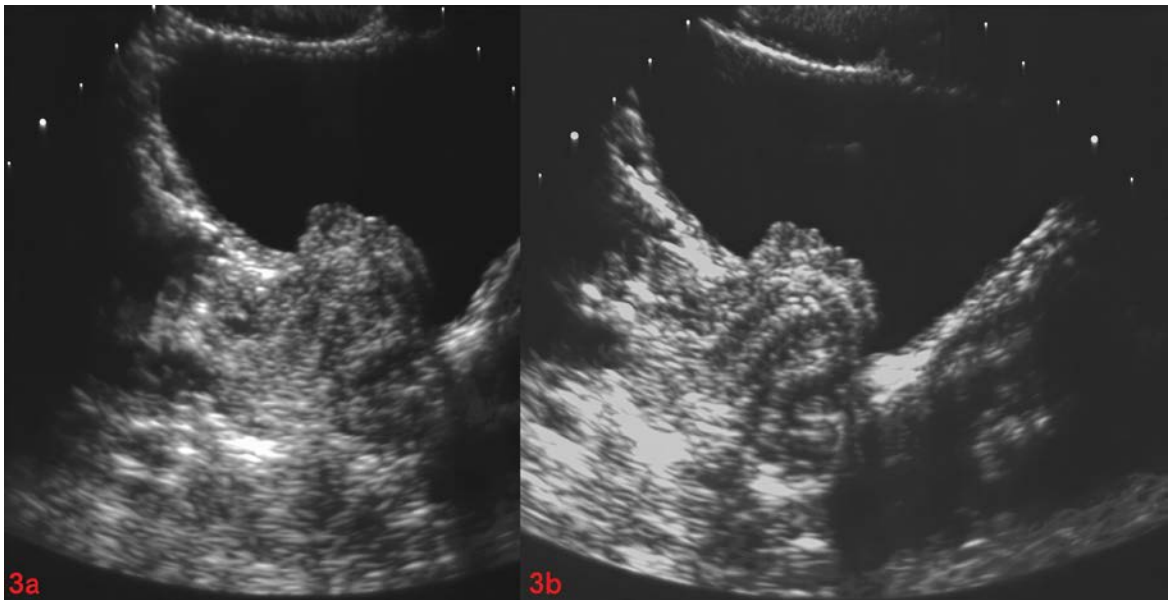

Figure 3 a-b *Axial sonograms which show a peculiar mass projecting into the urinary bladder. We can depict the helical configuration of the internal structure which means that something wrong has happened embryologically in the metanephric blastema*

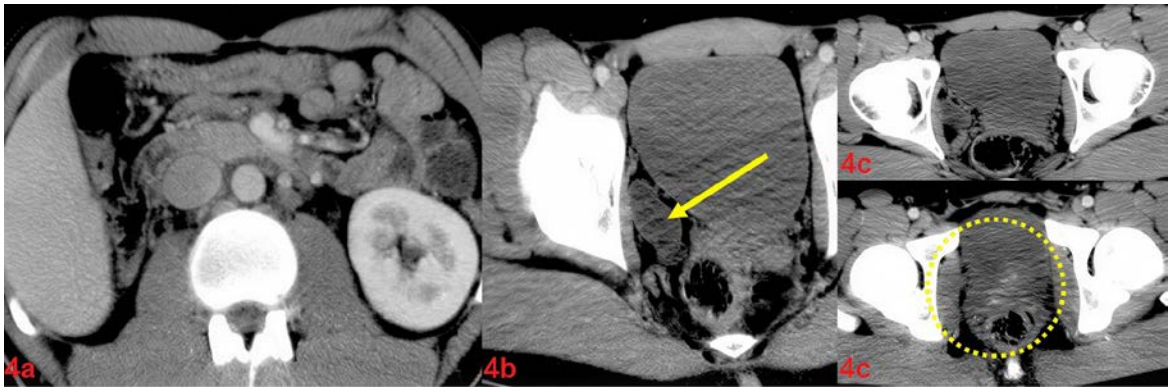

Figure 4 a-c *Axial CT images (a) of the upper abdomen which reveals the absence of the right kidney, (b) at the level of the urinary bladder which show a cystic tubular structure (Arrow) and (c) CT images which show a mass projecting to the urinary bladder (Circle)*

ocele + tubulocystic ureter in orthotopic position)

- **Type 2:** remnants of ureteric bud structures in an ectopic position, non-communicating or communicating with other structures (urethra, vagina).
- **Type 3:** abnormalities of the ureteric bud in addition to other abnormalities related to the portion of the mesonephric duct cranial to the ureteric bud such as Zinner syndrome and Herlyn-Werner-Wunderlich syndrome.

Given the complexity and heterogeneity of anomalies within Type 3, this group could be further subclassified according to patient's sex, reflecting the distinct embryologic and clinical patterns observed in males and females. Merrot et al., in their cohort study of 93 patients diagnosed with dysplastic kidney, reported that 15% (14/93) exhibited associated malformations of ipsilateral internal genitalia.[6] Male patients can present with Zinner syndrome, which comprises the triad of unilateral renal agenesis, ipsilateral ejaculatory duct obstruction and ipsilateral seminal vesicle cysts.[7] Other rarer male phenotypes include combinations such as renal dysplasia with vas deferens atresia and ipsilateral

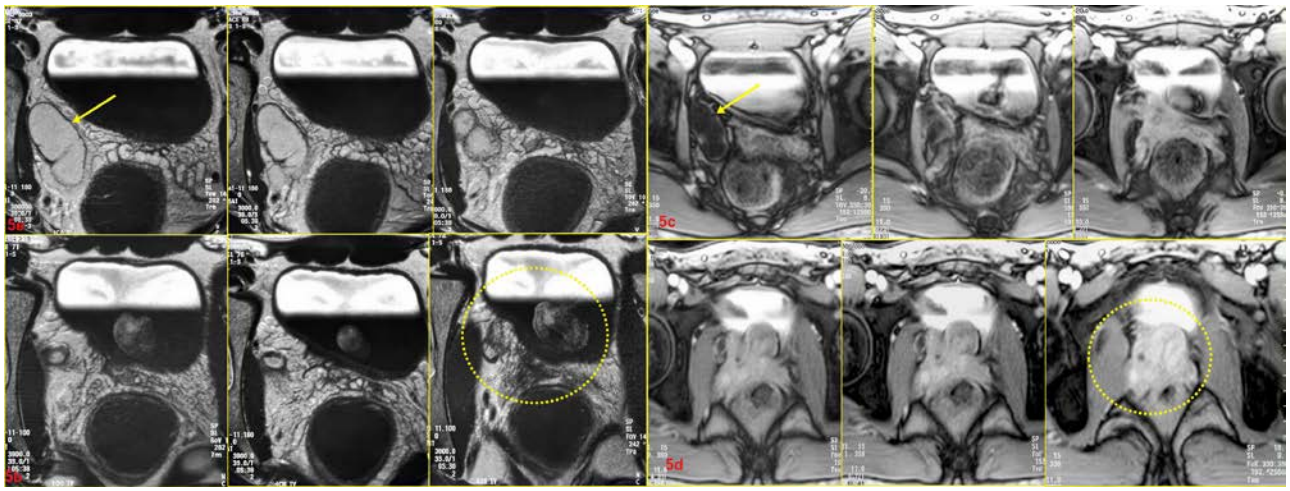

Figure 5 a-d *Axial T2-weighted images which show (a) clearly the cystic mesonephric duct (Arrow) and (b) the abnormal metanephric blastema (Circle). Axial post contrast T1-weighted images which show clearly (c) the cystic mesonephric duct (Arrow) and (d) the abnormal metanephric blastema (Circle)*

absent seminal vesicle[8], or renal dysplasia associated with ureterocele and grossly cystic epididymis. Female patients may present with Herlyn-Werner-Wunderlich also known as OHVIRA syndrome (ipsilateral renal anomalies, obstructed hemivagina) and its variants[9], and tubulocystic malformations with accompanied Gartner's duct cysts[5]. OHVIRA syndrome is thought to be caused by abnormal development of the Wolffian and Mullerian ducts.[9]

In this article we describe two cases of abnormal mesonephric duct persistence, the first one without any other coexisting abnormalities and the second one accompanied with abnormal development of metanephros. According to Coleman's classification, our patient described on second case belongs on Type 1b category. The persistence of a portion of the mesonephric duct along with the abnormal formation of metanephros (abnormal interaction of the ureteric bud with metanephric blastema) appears as a communicating tubulocystic lesion in the pelvic region, with the urinary bladder. The dysplastic kidney remained in an ectopic position and did not ascend to the final lumbar position, in contrast to other cases described.[5] Singh et al. also presented a male patient with a hypoplastic kidney along with a small blind ending non-communicating ureter-like structure located in the normal lumbar region.[10] Our first case cannot be classified according to Colman's classification due to normal kidney existence. (Fig. 1), (Fig. 2) To the best of our knowledge, this is the first case reported in the literature describing persistence of the mesonephric duct without associated ipsilateral renal agenesis or dysgenesis.

The majority of Coleman's patients belonged to the Type 1 group and were asymptomatic, apart from one patient which presented with infection and purulent vaginal discharges (Type 2) and a patient with Zinner syndrome, who presented with testicular pain (Type 3). Joshi et al. reported two cases with Type 2 abnormalities, which presented with occasional fever and dribbling of urine from the vagina and abdominal distention respectively.[11] Other symptoms described were occasional low flank or perineal pain, dysuria and epididymitis.[8] In cases of compound anomalies of the ureteric bud and the cranial portion of mesonephric duct, symptoms may not appear until after puberty.

The pathophysiology behind these rare abnormalities is not well understood yet. It is speculated that the failure of the ureteric bud to arise or an abnormal reciprocal interaction between the ureteric bud and the metanephric blastema leads to renal agenesis or creation of a dysplastic kidney. Furthermore, the defective incorporation of the ureteric bud with the bladder (trigone) may result in cystic abnormalities of the terminal ureter such as ureterocele or ectopic insertion into the urogenital sinus.[11] Weyman et al. mentioned that when the ureteric bud originates more cephalad than normal, may fail to meet the metanephric blastema in the proper orientation and position in order to

stimulate the creation of a normal kidney resulting in renal dysplasia or agenesis and ectopic ureter insertion. Abnormal development of the mesonephric duct itself may result in more complex abnormalities affecting and other duct derivatives (Type 3 anomalies).[8] To et al. described a case of a 1-year-old boy with an absent right kidney, which was operated due to impalpable right testis. In the laparotomy were found two tubular structures (ureter-like appearance) with no continuity with the bladder, fusing into a common tube about 2-3 cm from the bladder neck. The one's cranial end was blind and the others was connected to the dysplastic testis (respectively).

This case shows an abnormal development on the total extent of the mesonephric duct.[12] As far as the first case, the pathophysiology may be more complex. The normal development of both kidneys indicates the normal interactions between the ureteric buds and metanephric blastemas. One possible mechanism of this very rare entity could be the existence of an extra, ectopic ureteric bud (ureteric bud duplication), cranially to the ureteric bud that interacted normally with metanephric blastema.

The extra ureteric bud could conceivably grow to the bladder but not meet metanephric mesenchyme, creating a blind tubular structure. Other speculations may include defects in the apoptotic machinery of the mesonephric duct and absence or dysfunction of a local mesenchymal transcriptional factor, chicken ovalbumin upstream promoter transcription factor II (COUP-TFII) in the mesenchyme of the right mesonephros. COUP-TFII normally inhibits expression of the fibroblast growth factors (FGFs) that are necessary for Wolffian duct maintance, leading to regression of these ducts. Zhao et al. found in mice models that absence of COUP-TFII in the mesenchyme of the mesonephros led to ectopic maintenance of Wolffian ducts in XX embryos independent of androgen actions.[13]

Diagnostic imaging serves as the cornerstone for evaluating structural abnormalities of the genitourinary system. The aforementioned malformations often are asymptomatic or present with nonspecific clinical signs, making radiological evaluation indispensable. Ultrasound is typically the first-line modality, particularly in pediatric and prenatal settings, due to its non-invasiveness and diagnostic utility. It allows to assess the location and morphology of the kidneys, ureters insertion spots, as well as other possible co-existing abnormalities. MRI is the gold standard method for the evaluation of the kidneys, the collecting systems and the genital system. The absence of a kidney or presence of a dysplastic kidney should arouse concerns of coexisting abnormalities in the rest urinary system or genitalis. Genital abnormalities (e.g. seminal vesicle cysts, epididymal cysts and uterine or vaginal anomalies) may not present until after puberty, so follow-up of patients should be planned with this in mind.

In this retrospective research we found two very interesting cases of mesonephric duct persistence with an in-depth analysis of imaging characteristics and pathophysiological mechanisms. As far as we are aware, this is the first case described with a persistent mesonephric duct without ipsilateral renal absence or dysgenesis. This study had limitations also. The number of patients included was short due to the rarity of these entities. Furthermore, due to scarcity of similar cases in the literature, the definite pathophysiology mechanism of these abnormalities could not be established.

Conclusion

Persistence of mesonephric duct represents a rare but clinically significant spectrum of anomalies, underscoring critical disruptions in the tightly regulated pathways of embryological regression and tissue differentiation. High index of suspicion and clinical awareness are required, in order to establish the proper diagnosis, as they may present incidentally or with general symptoms such as infection and occasional low abdominal pain. Further studies are needed to better understand their developmental mechanisms and to refine imaging and treatment for complex cases. **R**

Author statements

Acknowledgments: N/A

Ethical approval: Ethical approval was not required for this study.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Competing interests: The authors declare no conflict of interest.

Informed Consent: Informed consent was obtained from legal guardians. All personal information of the patients were completely anonymized.

References

1. Howitt BE, Nucci MR. Mesonephric proliferations of the female genital tract. Pathology (Phila) 2018;50:141–50. https://doi.org/10.1016/j.pathol.2017.11.084.
2. Houat AP, Guimarães CTS, Takahashi MS, Rodi GP, Gasparetto TPD, Blasbalg R, et al. Congenital Anomalies of the Upper Urinary Tract: A Comprehensive Review. RadioGraphics 2021;41:462–86. https://doi.org/10.1148/rg.2021200078.
3. Carlson BM. Urogenital System. Hum. Embryol. Dev. Biol., Elsevier; 2014, p. 376–407. https://doi.org/10.1016/B978-1-4557-2794-0.00016-4.
4. Lee JH, Kim H, Kim CH, Ro JY. Hyperplasia of mesonephric remnant, epididymal type: A case report. Basic Appl Pathol 2009;2:69–71. https://doi.org/10.1111/j.1755-9294.2009.01041.x.
5. Coleman R, Sanchez O, Ghattaura H, Green K, Chandran H, McCarthy L, et al. Tubulocystic anomalies of the mesonephric duct associated with ipsilateral renal dysgenesis. J Pediatr Urol 2019;15:46.e1-46.e6. https://doi.org/10.1016/j.jpurol.2018.07.021.
6. Merrot T, Lumenta DB, Tercier S, Morisson-Lacombes G, Guys J-M, Alessandrini P. Multicystic dysplastic kidney with ipsilateral abnormalities of genitourinary tract: Experience in children. Urology 2006;67:603–7. https://doi.org/10.1016/j.urology.2005.09.062.
7. Mehra S, Ranjan R, Garga UC. Zinner syndrome—a rare developmental anomaly of the mesonephric duct diagnosed on magnetic resonance imaging. Radiol Case Rep 2016;11:313–7. https://doi.org/10.1016/j.radcr.2016.04.002.
8. Weyman PJ, McClennan BL. Computed tomography and ultrasonography in the evaluation of mesonephric duct anomalies. Urol Radiol 1980;1:29–37. https://doi.org/10.1007/BF02926597.
9. Schlomer B, Rodriguez E, Baskin L. Obstructed hemivagina and ipsilateral renal agenesis (OHVIRA) syndrome should be redefined as ipsilateral renal anomalies: Cases of symptomatic atrophic and dysplastic kidney with ectopic ureter to obstructed hemivagina. J Pediatr Urol 2015;11:77.e1-77.e6. https://doi.org/10.1016/j.jpurol.2014.12.004.
10. Singh K, Jain M, Pujani M, Chauhan V, Khandelwal A, Abbas SZ. Congenital Unilateral Hypoplasia of Kidney with Mesonephric Remnants in the Ureter: A Case Report. Indian J Nephrol 2023;33:373–6. https://doi.org/10.4103/ijn.IJN_579_20.
11. Joshi AR, Muthe MM, Gonapati S, Agarwal MR, Rai PR. Ipsilateral renal dysgenesis or agenesis with tubulocystic anomalies of the mesonephric duct. SA J Radiol 2023;27:2700. https://doi.org/10.4102/sajr.v27i1.2700.
12. To H, Hutson J, Taylor R. Persistent mesonephric duct found at laparoscopy for impalpable testis. J Pediatr Urol 2007;3:142–4. https://doi.org/10.1016/j.jpurol.2006.05.012.
13. Zhao F, Franco HL, Rodriguez KF, Brown PR, Tsai M-J, Tsai SY, et al. Elimination of the male reproductive tract in the female embryo is promoted by COUP-TFII in mice. Science 2017;357:717–20. https://doi.org/10.1126/science.aai9136.

Ready - Made Citation

Dimitrios Kourdakis MD, Alexandros Tsitouridis MD, Elena Hadjichristou MD, Georgios Ursof MD, Eleni Makridou MD, Maria-Michailia Vogiatzi MD. Radiological Characterization of Rare Congenital Malformations of the Mesonephric Duct: Imaging and Developmental Considerations, *Hell J Radiol 2026*; 11(2): 22-29.