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CASE REPORT

Crossed Fused Renal Ectopia with Herniation into the Scrotum: A Donor Case Report

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Abstract

Background: Congenital kidney anomalies, such as horseshoe kidney and unilateral renal agenesis, are rare, occurring in 0.2% and 0.1% of live births, respectively.

Methods: During routine dissection of a whole-body donor, a rare case of a right-sided renal ectopia with suspected scrotal herniation was observed. The donor, a 108-year-old white male with a history of arrhythmia, lacked a left kidney with no evidence of nephrectomy.

Results: The remaining kidney was ectopically located in the right iliac fossa, with its inferior pole terminating at the inguinal ligament. The parenchyma was embedded superiorly within the psoas major muscle and extended inferiorly into the scrotal sac. Fascial attachments to perinephric fat were observed, with the fat herniating into the scrotum. Within the scrotum, the perinephric fat and its fascial connections were fused with the right testicle, which had an elongated vas deferens. The kidney appeared to be fused, with evidence of a shared blood supply and ureter configuration consistent with a crossed fused renal ectopia.

Conclusion: This study identifies a unique case of a pelvic kidney with perinephric fat herniation into the scrotum, immobilizing the kidney. It highlights the complex interplay between urinary and reproductive anatomy and underscores the importance of recognizing such variations. These can impact renal function, fertility and surgical outcomes. Greater awareness of these anomalies can improve diagnostic accuracy and inform clinical decision making.

Key Words: *Congenital kidney anomalies; Herniated kidney; Scrotal kidney; Cross fused kidney*

Introduction

Kidney development is a complex, tightly regulated process that begins early in embryogenesis. The kidneys develop from intermediate mesenchyme through two key structures: the ureteric bud (metanephric diverticulum) and the met nephrogenic blastema (mass of mesenchyme). These structures eventually form the collecting and excretory systems. Initially developing in the pelvis, the kidneys migrate to their final retroperitoneal position (T12–L3). This process is under the influence of coordinated genetic and molecular signals guiding differentiation, vascularization, and integration into the urinary system [1].

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Disruptions in these developmental processes can lead to a range of congenital kidney anomalies.

These anomalies can be categorized into structural anomalies, positional and fusion anomalies, and anomalies of the collecting system and ureters. An example of a structural anomaly is renal agenesis, which is the complete absence of one (unilateral) or both (bilateral) kidneys. Bilateral agenesis is rare (1 in 3000-4000 births) and is incompatible with life, while unilateral agenesis (URA) is more common (1 in 2000 births) and usually asymptomatic. URA is an example of a solitary kidney which can occur either by congenital absence or acquired loss and is often seen in conjunction with additional structural anomalies [1,2]. Congenital kidney anomalies also include horseshoe kidney, which results from the fusion of the kidneys at their lower poles. This kidney is located at the level of the lower lumbar vertebra because its ascent is prevented by the origin of the inferior mesenteric artery from the aorta [3].

Positional and fusion anomalies are relatively common among congenital renal anomalies and can lead to clinical complications depending on their location and extent. Horseshoe kidney represents a fusion anomaly where most commonly the lower poles of the kidney are joined across the midline. An example of a positional kidney anomaly is nephroptosis, characterized by excessive kidney mobility, in which the kidney descends into the pelvis when the patient is in an upright position [2]. In addition to nephroptosis, ectopic kidneys are commonly reported positional anomalies. Ectopic kidneys are kidneys in an abnormal location due to failure of the kidneys to ascend to the retroperitoneal renal fossa during development. Pelvic kidneys are the most common type of ectopia; however, ectopia can be in the iliac, thoracic, or abdominal regions [1].

Positional kidney anomalies can present with complications affecting renal function, urinary tract integrity, and reproductive health1. They can also be at risk for herniations, particularly ectopic and nephroptotic kidneys due to their abnormal location and motility [4-6]. In rare cases of nephroptosis, the kidney may descend below the inguinal ligament, even reaching the scrotum. Hsabo et al. (2023) described this rare case of a scrotal kidney in an 82-year-old male, where the kidney fully descended into the scrotum, mimicking an inguinoscrotal hernia [2]. However, the mechanisms underlying such descent and potential role of herniation in renal immobilization remain unclear. Most of the literature relating to renal hernias has focused on nephroptosis and ureteroinguinal hernias, with studies reporting both symptomatic and incidental cases [2,7-8].

Additionally, herniation of the perinephric fat has also been reported. Perinephric fat herniation has been reported in the supraphrenic region, though its clinical implications remain unclear, as well as the lumbar triangle region [9,10]. Leroux (1965) described several cases where perinephric fat extended above the diaphragm, mimicking thoracic masses on imaging [9]. More recently, Morgan et al. (2017) documented a rare case of inferior perinephric fat herniation through the inguinal canal in association with ureteral obstruction and forniceal rupture [10]. Notably, the pathology in the case report occurred in the absence of underlying anatomical variation, such as renal ectopia.

This study presents a unique case of a pelvic kidney with a herniation into the scrotum representing previously unreported anatomical variations. By raising awareness of renal ectopia and herniation, this study aimed to highlight the clinical relevance of this specific congenital renal anomaly and its implications for guiding future diagnostic and surgical strategies. The researchers hypothesize that the observed pelvic

kidney is a solitary kidney with perinephric fat herniation into the inguinal canal and scrotum, which may contribute to renal immobilization and could have implications for urinary and reproductive health.

Materials and Methods

A whole-body donor from the Ohio University Heritage College of Osteopathic Medicine Whole Body Donation Program, embalmed with a formaldehyde-based solution, was initially dissected as part of routine first year medical student anatomy curriculum. The donor, a 108-year-old white male, with arrhythmia reported as the cause of death, was found to be missing a left kidney, with no evidence of surgical nephrectomy. The students' dissection began with the anterior abdominal wall and continuing into the abdominal and pelvic cavities, following Grant's Dissector [11]. A midline skin incision was made from the xiphoid process to the pubic symphysis, followed by lateral incisions to reflect the skin and expose the superficial fascia and musculature [12]. Students then reflected the external and internal oblique muscles, transversus abdominis muscle and transversalis fascia to access the peritoneal cavity12. During the course of the inguinal canal and spermatic cord dissections, kidney parenchyma was found in the right lower pelvis with attachments extending through the inguinal canal into the scrotum.

After this discovery, a horizontal cut was made through the lumbar intervertebral disc and body at the level of L2. Then, a sagittal cut was made to left of midline, to preserve the anomaly, abdominal aorta, inferior vena cava, and bilateral common iliac arteries. At that point, the routine dissection by the students was discontinued on the right side, and the donor body was preserved for subsequent research investigation. The left hemipelvis was preserved for dissection by the medical students, and the dissection on this side revealed normal anatomy of the retroperitoneal structures, inguinal region, and male external genitalia, except for the kidney and ureters.

The right hemipelvis dissection was later resumed by the research team with the goal of conducting a more detailed anatomical investigation (Figure 1). A stepwise dissection was performed to further investigate the abdominal and pelvic structures, with particular attention to the vasculature, urogenital anatomy, and surrounding soft tissues.

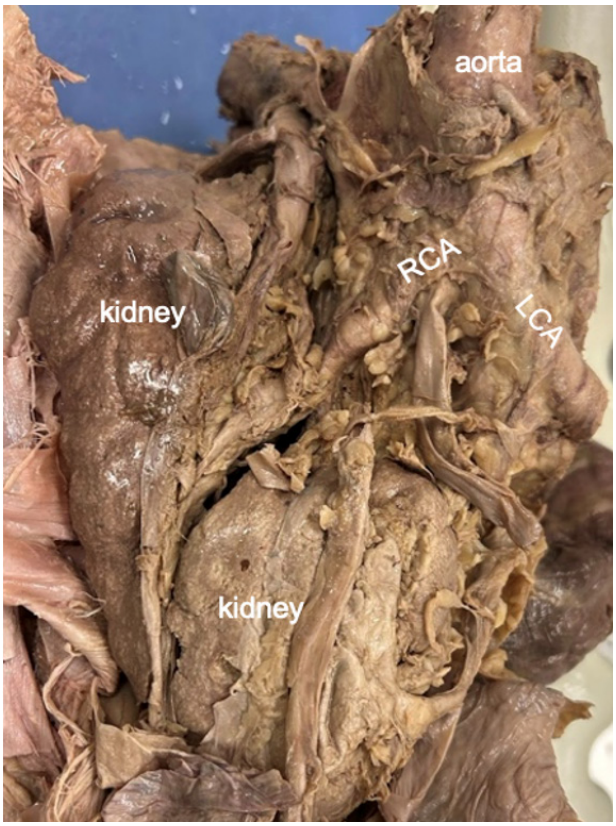

Figure 1) *Before investigative dissection began. RCA = Right Common Iliac Artery; LCA= Left Common Iliac Artery.*

Dissection began by determining the boundaries of the kidney, examining attachments, and taking photographs at each step in the dissection. The fascia surrounding the kidney was dissected to allow better visualization. To free the kidney from attachments, the kidney parenchyma was then reflected off the belly of the psoas major muscle. After this step, the vasculature and ureters were dissected. Careful dissection techniques were employed to preserve tissue planes and anatomical relationships.

After the kidney was fully exposed, dissection was then focused on its attachment to the scrotum. This began with skinning of the scrotum and reflecting fascial layers and associated soft tissue compartments, revealing the herniated mass. The herniated mass was traced back up through the inguinal canal and into the pelvis, noting its relationships to the normal anatomy.

Starting at the inferior pole of the kidney, the fascial herniation attachments were isolated from the tissue anchoring the mass to the pelvis. Then the herniated tissue was identified, and the inguinal ligament was released for better visualization. The fascia encapsulating the herniated tissue was then opened to allow for exploration of its contents. The left hemipelvis dissection performed by the students allowed for anatomical comparison. Documentation of structural relationships, dimensions, and tissue characteristics was carried out through photographs, measurements with a ruler, and descriptive notes throughout each stage of the dissection. Measurements included kidney parenchyma sections; left and right vas deferens; left and right testes; and the fascial extensions stemming from the kidney. This investigation was approved by Ohio University's Body Donation Program on February 2, 2024.

Results

Location and Fascia

In the right hemipelvis, a crossed fused ectopic kidney was identified deep within the iliac fossa and partially embedded in the psoas major muscle (Figure 2). The kidney was anterolateral to the inferior vena cava (IVC) and aorta. The kidney exhibited a fused morphology with three distinct parenchymal regions: superior (12.9 cm), inferior (8.8 cm), and intramuscular (12.2 cm) (Figure 3). Each component was separated by thin fascial planes. Due to embryonic development of the kidney, it appears crossed and fused due to the distinct renal parenchyma planes and separate blood supply and ureters.

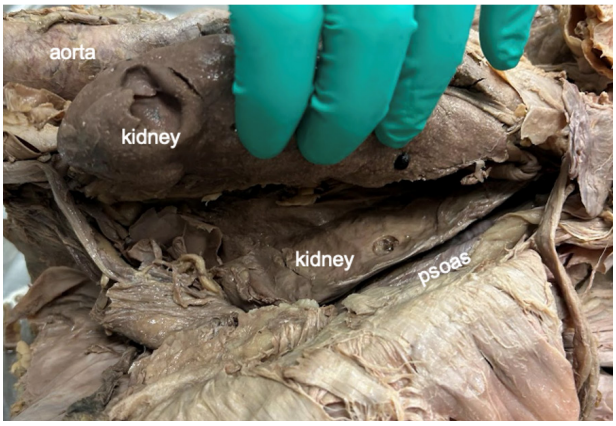

Figure 2) *Kidney parenchyma embedded within the psoas major muscle.*

Figure 3) *Fused kidney with separate fascial planes. RA = Renal Artery; RCA = Right Common Iliac Artery; LCA = Left Common Iliac Artery.*

Vasculature and Ureters

Despite this fusion, dual renal blood supply was observed, rather than the normal singular renal artery: (1) a right superior renal artery originating from the abdominal aorta, below the inferior mesenteric artery (IMA) and above the bifurcation of the common iliac arteries, and (2) a right inferior renal artery branching from the left common iliac artery (Figure 4). There was no evidence of nephrectomy, as indicated by the absence of vascular ligation or surgical alteration. Two ureters were identified, each draining a separate collecting system. One ureter coursed along the right pelvic wall and entered the bladder on the ipsilateral side, while

the second ureter crossed the midline to enter the contralateral side of the bladder (Figures 5 and 6). The ipsilateral ureter stemmed from the inferior portion of kidney parenchyma whereas the contralateral ureter took a longer course from the superior kidney parenchyma.

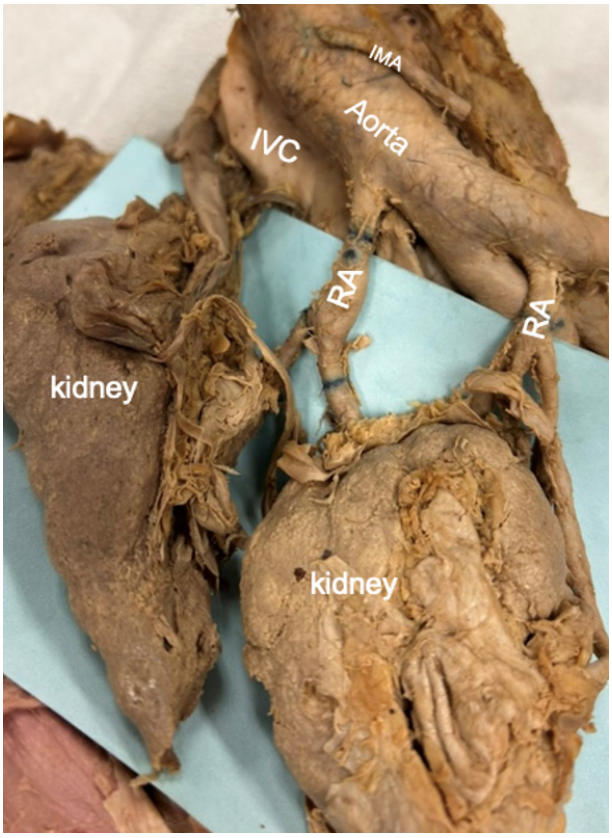

Figure 4) *Blood supply to the separate kidney parenchyma. IVC = Inferior Vena Cava; RA = Renal Artery; IMA = Inferior Mesenteric Artery.*

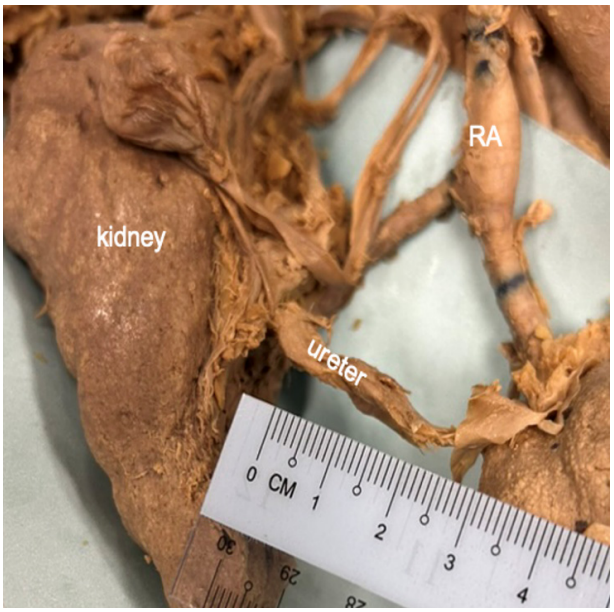

Figure 5) *Superior kidney parenchyma ureter. RA = Renal Artery.*

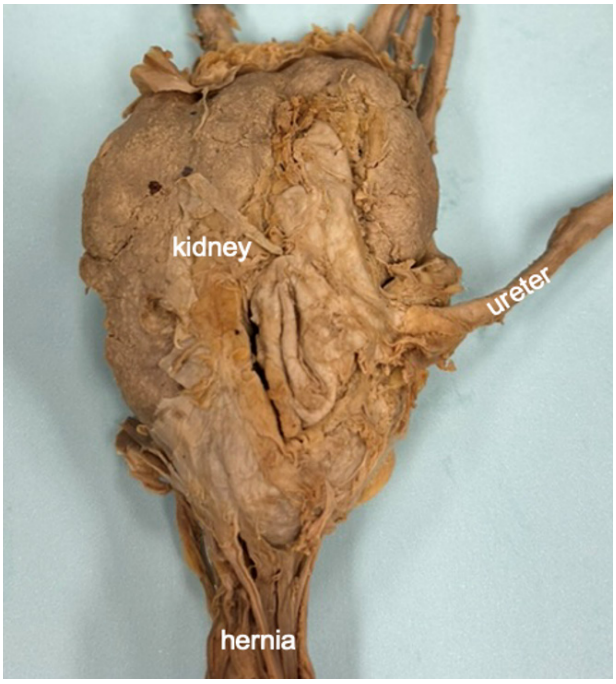

Figure 6) *Inferior kidney parenchyma ureter.*

Herniation and Scrotum

Further dissection revealed significant indirect inguinal herniation of perinephric fat extending from the inferior pole of the kidney through the inguinal canal into the scrotum (Figure 7). The herniated fat was encapsulated within the renal fascia and was continuous with the perinephric space. Within the scrotum, the fascial extension enveloped the right testicle and vas deferens, both of which were displaced and altered in morphology. The right vas deferens measured 23.8 cm and displayed a tortuous path compared to the left vas deferens, which measured 15.1 cm (Figure 8). The right testis measured 4.9 cm in length and 0.8 cm in width, whereas the left measured 3.8 cm in length and 1.7 cm in width (Figure 9). The fascial extensions from the inferior pole and intramuscular region of the kidney measured 20.2 cm and 24.0 cm, respectively (Figures 10 and 11). No perinephric fat or adrenal gland was observed surrounding the superior aspect of the kidney, further supporting the conclusion that the herniated tissue represented displaced perinephric fat. The fascial capsule and fat lobules were clearly delineated from surrounding tissues.

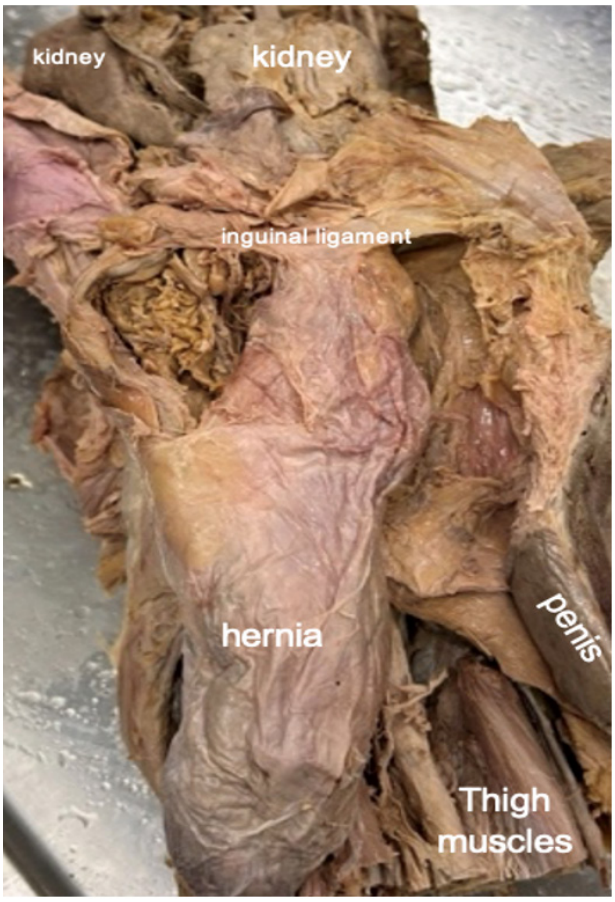

Figure 7) *Herniated tissue stemming from kidney parenchyma (pre-dissection).*

Figure 8) *Right vas deferens and testicle.*

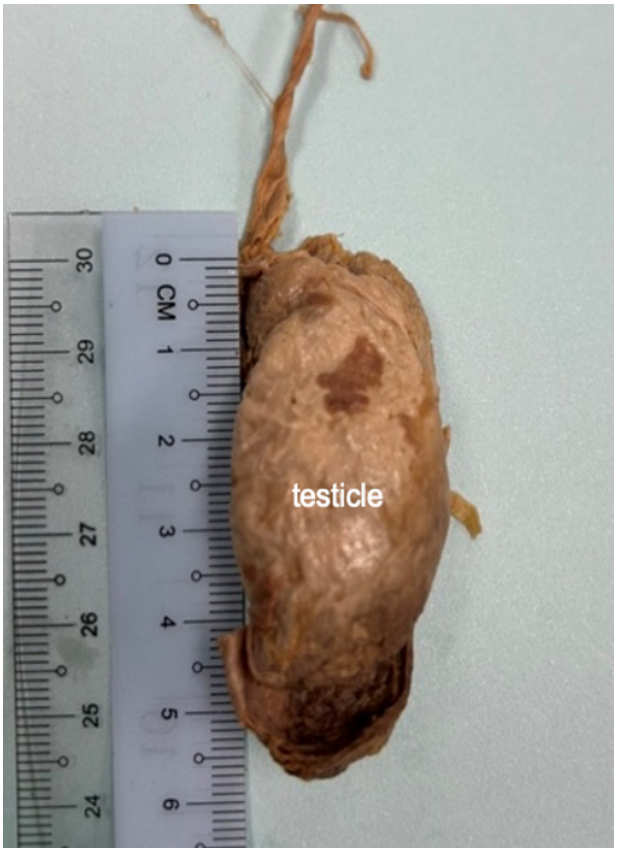

Figure 9) *Right vas deferens and testicle.*

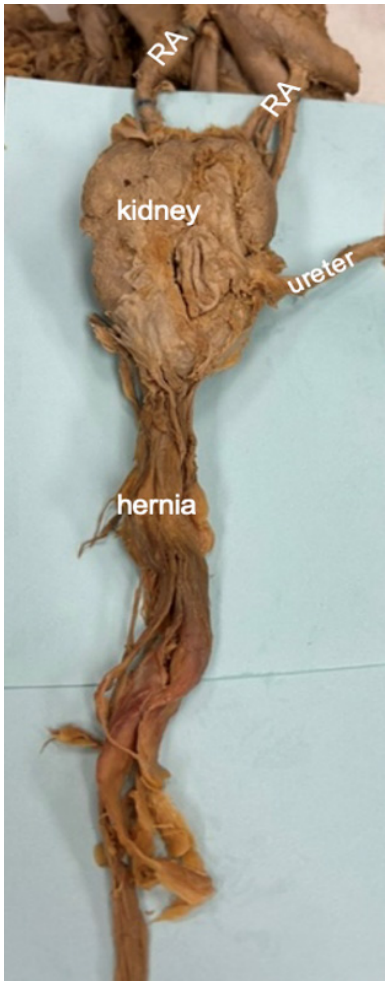

Figure 10) *Herniated tissue stemming from kidney parenchyma (post-dissection). RA = Renal Artery.*

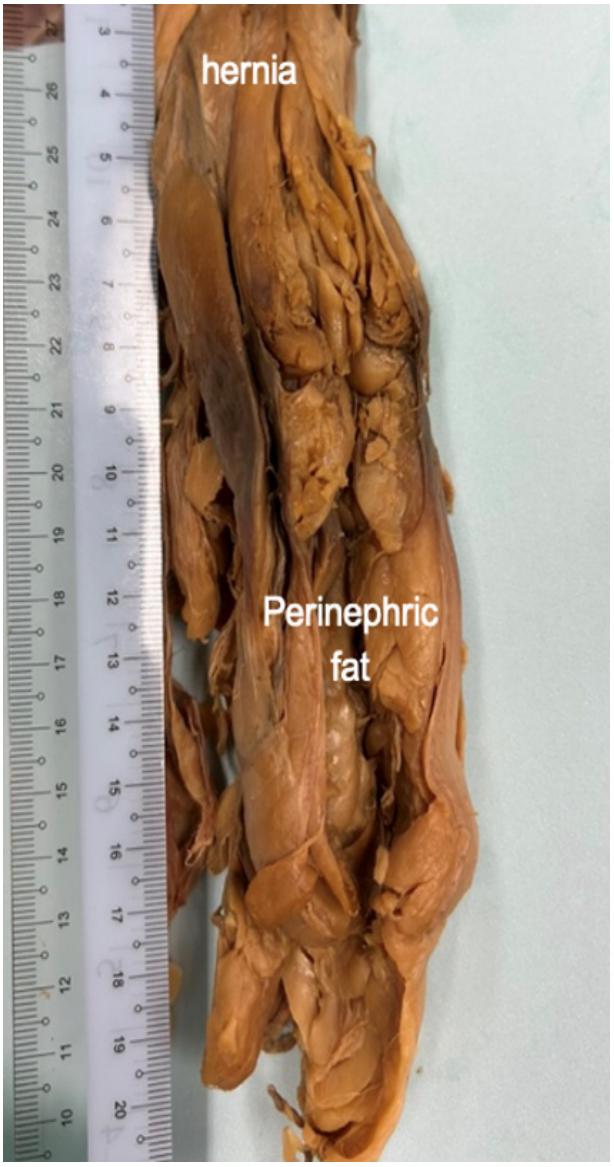

Figure 11) *Herniated perinephric fat lobules stemming from intramuscular kidney parenchyma.*

Discussion

This case draws attention to the intersection of renal ectopia and inguinal herniation. Initially thought to be a solitary kidney, further investigation revealed a crossed fused kidney ectopia accompanied by perinephric fat herniation. As reported in the literature, crossed renal ectopia is a rare congenital anomaly that involves one kidney being transposed to the opposite side of the body, while its ureter crosses the midline to enter the bladder in its usual anatomical position [13,14]. The unusual descent of perinephric fat in this case appears to be a consequence of the underlying congenital anomaly, resulting in herniation that may anchor the kidney in an ectopic position and potentially influence urinary and reproductive function. While individual renal anomalies such as renal ectopia and inguinoscrotal herniation have been independently described in the literature, their combination in a single presentation, particularly involving parenchymal, vascular, and ureteral abnormalities has not been documented. These findings expand the spectrum of recognized congenital renal and urogenital anomalies.

Ectopic kidneys are among the most common congenital anomalies of renal position, frequently resulting from arrested cranial migration during embryogenesis1. The observation of an inferiorly located kidney fused with the psoas major muscle, dual ureters, and aberrant vasculature further underscores the embryologic complexity of renal morphogenesis. The presence of dual ureters and the vascular supply with contributions of the contralateral common iliac artery is consistent with previously documented cases of crossed fused ectopia or duplicated collecting systems, which are commonly associated with solitary kidneys [15].

Crossed Fused Kidney Ectopia (CFRE) a is a rare congenital anomaly that occurs in 1 in 1000 live births; however, the exact incidence is unknown due to their asymptomatic nature [16]. Postmortem, the incidence of CFRE can vary from 1 in 2000 to 1 in 7500 [17,18]. CFRE is more common in males and found on the right side of the pelvic cavity, similar to what is presented in this case study [19]. The cause of CFKE is unknown, however it may be due to a variety of congenital issues, such as abnormal ureteric bud development during weeks 4-8 of gestation, disrupted blood supply to the ascending kidneys, and/or environmental influences [17,20,21].

The significant herniation of perinephric fat

through the inguinal canal into the scrotum is a novel feature. Although ureteroinguinal hernias have been documented, particularly in patients with associated renal malformations7, the majority of these involve the ureter and are classified as paraperitoneal or extraperitoneal types. In contrast, this case uniquely involved perinephric fat herniation without ureteral displacement into the scrotum, suggesting a different mechanistic pathway. The continuity of the herniated fat with the renal fascia and its encapsulation supports the hypothesis that the perinephric fat migrated alongside the kidney, potentially tethered during failed ascent or facilitated by fascial weakness.

While Morgan et al. (2017) illustrates acute pathology of perinephric fat herniation in the setting of an otherwise orthotopic kidney, the present case is notably different in both anatomical complexity and clinical context [10]. This current case demonstrates a pelvic kidney with fused, multi-lobed parenchyma embedded within the psoas major muscle, dual renal arteries, and bilateral ureters draining into the bladder. These features are suggestive of a significant anatomical variation, consistent with CFRE. Most significantly, extensive perinephric fat herniation was observed through the inguinal canal into the scrotum, continuous with the renal fascia and not accompanied by ureteral displacement or obstruction. This anatomic variation differs from previously documented cases in both origin and trajectory. Rather than an acquired or pressure-related fat herniation from a normally positioned kidney10, this case likely reflects a congenital failure of renal ascent with associated tethering and downward migration of perinephric structures.

Notably, supraphrenic herniation of perinephric fat has been described radiographically, but its clinical implications were minimal8. This case thus presents the first known example of inferior migration of perinephric fat into the scrotum from a crossed fused ectopic kidney. The direction and origin of this displacement that may have implications for testicular displacement, vas deferens morphology, and potentially fertility, as suggested by the observed alterations in the right testis and vas deferens dimensions in this case.

The altered course and length of the right vas deferens, alongside testicular asymmetry may have functional implications that warrant further investigation. Although congenital solitary kidneys are often asymptomatic, they are frequently associated with genitourinary anomalies, including reproductive tract malformations [1,14]. This further supports the possibility of shared embryologic origins and developmental disruption affecting both renal and reproductive structures.

This case is particularly noteworthy due to the donor's remarkable age of 108 years, which brings a unique perspective to these findings. There are many questions surrounding the morbidity of such a novel renal anomaly, but the advanced age of the donor clearly indicates preservation of normal physiology of the kidney and surrounding vital organ structures. The nature of donor anatomical studies greatly limits the ability to assess the functional implications of such anomalies.

This study is not without limitations. Due to the anonymity of the whole-body donors, no associated medical records or personal health information were able to be accessed. Therefore, correlating data about congenital kidney abnormalities and the reproductive or general health of the donor in this study could not be fully established. Additionally, this is a report from one donor, so therefore cannot be generalizable. While dissections for this study were performed carefully and thoughtfully, prior dissection by students before the investigation, such as accessing the inguinal canal, may have limited data that could have been presented.

Future studies may benefit from correlating anatomical findings with patient symptoms, imaging data, and surgical outcomes, although body donor programs, such as the one utilized in this case, prioritize privacy of the donors and their families.

This case highlights the importance of considering atypical renal anatomy in surgical, diagnostic, and educational contexts. Incidental findings of ectopic kidneys or herniated fat may be misinterpreted radiographically or intraoperatively, especially if the anomaly is not anticipated. Furthermore, the presence of such complex anomalies reinforces the value of donor dissection in identifying and understanding rare anatomical presentations.

Conclusion

This case expands upon the current anatomical understanding of congenital renal anomalies by reporting a presentation of perinephric fat herniation into the scrotum in the context of a crossed fused ectopic kidney. These findings suggest a potential mechanism of renal immobilization through fascial fusion, with implication for urinary and reproductive complications. The rare configuration highlights the importance of detailed anatomical knowledge when approaching genitourinary surgery or diagnostic evaluation. Future investigation into similar presentations will inform clinical approaches to renal ectopia and inguinal-scrotal pathology.

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