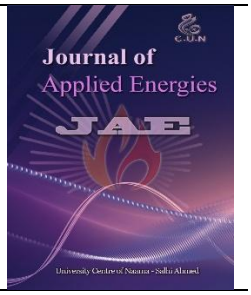
Journal of Applied Energies 01 (2022) 49-58

Journal of Applied Energies



The impact of anatomical variations and renal malformations on the flow of urine through the megaureters and the occurrence of renal failure

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Abstract: Unilateral renal agenesis is a congenital malformation characterized by the complete absence of one kidney. Megaureters, on the other hand, are urinary tract anomalies characterized by abnormal dilation of the ureters, resulting in obstruction of urine flow. This case study aims to analyze the impact of unilateral renal agenesis on the development of megaureters and the obstruction of urine flow through the ureter. Follow-up of a patient from fetal age to five years of age highlights the correlation between unilateral renal agenesis and the accelerated development of obstructive megaureters. The results showed that the absence of a functional kidney was associated with the presence of voluminous megaureters, leading to obstruction of urine flow. This study highlights the importance of understanding the underlying mechanisms of these malformations and developing optimal management strategies to prevent renal failure in patients with unilateral renal agenesis and obstructive megaureters.

Keywords: unilateral renal agenesis, megaureters, obstruction of urine flow through the urinary tract, congenital renal malformations.

1. INTRODUCTION

The development of the kidneys is a complex and crucial process that begins around the 4th week of gestation and is completed by approximately the 36th week [1, 2]. During this period, the nephrogenic cord derived from the intermediate mesoderm transforms into the urogenital ridge [3], located on either side of the aorta [4]. This ridge plays an essential role in kidney formation, which occurs through various key stages [5-8].

Initially, the pronephros, the first renal structure, forms and then completely regresses by the 4th week of pregnancy [9]. Subsequently, the mesonephros, which contains the nephrons (the functional units of the kidneys), develops and also contributes to the formation of the bladder [10, 11]. Finally, the metanephros, the ultimate stage of renal development, results from the union of the metanephric blastema. The structural maturation of nephrogenesis and the branching of the collecting ducts are regulated by the PAX-2 and WT-1 complexes [1, 12].

Starting from the 12th week of gestation, the definitive kidneys begin to produce urine. Simultaneously, the bladder and urethra form from the cloaca, the urogenital sinus, which is continuous with the allantois, which becomes the bladder [5, 6]. In females, the urethral bud develops to form the ureter, while the Wolffian duct regresses. In males, the Wolffian duct evolves to become the vas deferens [7, 10].

Renal and ureteral malformations are relatively common, affecting approximately 1 in 200 births. They account for 20 to 30% [13] of all congenital malformations and are responsible for 30 to 50% of cases of renal failure [1, 14, 15]. With advances in prenatal diagnosis, it is possible to detect these malformations before birth, thus informing parents and allowing for adequate neonatal management [16, 17].

In order to study the anatomical and embryological aspects of renal malformations, as well as evaluate their consequences on renal function, we conducted a retrospective study based on the analysis of epidemiological and clinical data to determine the correlation between anatomical variations of the urinary system and the incidence of renal insufficiencies.

The objective of our study is to deepen our understanding of the impact of unilateral renal agenesis on the accelerated development of megaureters. Although both are congenital malformations, the aim is to demonstrate whether unilateral renal agenesis truly accelerates the occurrence of complications due to megaureters.

2. ANATOMICAL VARIATIONS AND RENAL MALFORMATIONS

The kidneys can exhibit various anatomical variations and malformations that can have a significant impact on renal function and urine flow. Understanding these variations is crucial for assessing associated clinical consequences and improving patient management.

Anatomical variations observed in the kidneys include variations in size, shape, and position. For example, some individuals may have asymmetrical kidneys, where one kidney is larger than the other, or horseshoe kidneys, where both kidneys are fused at their lower poles. Additionally, variations in the number of renal lobes or the presence of supernumerary kidneys can also be observed [18, 19].

Common renal malformations can be classified into several categories. Among these, there are malformations of renal morphogenesis, such as renal agenesis (absence of one kidney) or renal dysplasia (abnormal development of renal tissues). Obstructive malformations, such as ureteral strictures or ureteral valves, can lead to obstructions of urinary flow. Cystic malformations, such as polycystic kidney disease, are characterized by the formation of cysts within renal tissues. Other malformations, such as renal sponge kidneys, renal diverticula, or renal vascular malformations, can also be observed [20-22].

These anatomical variations and renal malformations can have consequences on renal function and urine flow. For example, an obstructive malformation can result in urine retention in the kidneys, thereby increasing the risk of kidney infections and renal damage. Cystic malformations can impact renal function by reducing the ability of nephrons to properly filter the blood. Additionally, certain malformations may be associated with an increased risk of kidney stones or other urological complications [18, 19].

Indeed, studying and understanding these anatomical variations and renal malformations are essential to better evaluate their impact on renal function and develop appropriate management strategies. Improved knowledge of these conditions will enhance diagnostic and therapeutic approaches, as well as prevention strategies. By gaining a deeper understanding of these conditions, healthcare professionals can provide more accurate diagnoses, implement tailored treatment plans, and offer preventive measures to minimize the risks and complications associated with renal malformations. This ultimately contributes to improving patient outcomes and quality of life.

3. MATERIAL AND METHODS

The objective of this study is to analyze the impact of the congenital malformation of unilateral renal agenesis on the development of megaureter pathology. To assess the correlation between these two anatomical variations of the kidneys, we conducted a retrospective study based on the analysis of clinical data from a patient from fetal age to five years old. This approach allowed us to analyze the correlation between the two anatomical variations and identify factors associated with their relationship.

Our study relied on the analysis of medical records and a combination of computed tomography (CT) imaging and ultrasound to examine these anatomical variations of the renal system.

4. RESULTS AND DISCUSSION:

A clinical case was examined to highlight the correlation between unilateral renal agenesis and the presence of megaureters. The results provided a better understanding of how the renal malformation can influence the structure and function of the ureters, leading to the acceleration of complications associated with megaureter malformation. This study has contributed to deepening knowledge about these clinical conditions and could have significant implications for the management of patients with unilateral renal agenesis and megaureters. The findings of this study support the notion that the absence of a functional kidney in unilateral renal agenesis can result in the development of voluminous megaureters, leading to obstructive urinary flow. This provides valuable insights into the underlying mechanisms of these conditions and emphasizes the importance of early detection and appropriate management strategies.

Understanding the correlation between unilateral renal agenesis and megaureters can aid in the development of optimal treatment approaches to prevent renal complications and improve patient outcomes. It underscores the need for close monitoring and intervention in patients with these conditions to minimize the risk of renal failure. Further research and larger-scale studies are warranted to validate these findings and explore additional factors that may influence the relationship between unilateral renal agenesis and megaureters. The ultimate goal is to enhance the understanding and management of these congenital renal malformations, leading to improved patient care and outcomes.

4.1 UNILATERAL RENAL AGENESIS

4.1.1 Data

In this study, the case discussed involves a 27-week fetus of a 31-year-old patient who had a previous pregnancy (G2P1) and presented for her second pregnancy. During the first-trimester

ultrasound (T1), the nuchal translucency was measured at 1.2 mm with a crown-rump length of 54.24 mm. Second-trimester serum markers (T2) revealed a result of 1/1965 (αFP = 0.76 MoM and HCG = 0.74 MoM). The second-trimester ultrasound showed normal fetal development, except for the left kidney, which was small in size and in a pelvic position. Suspicion of left unilateral renal agenesis was raised at 27 weeks of gestation. Through detailed questioning, it was discovered that there was a family history of a single hypertrophied kidney (with spinal anomalies).

The study began by conducting a baseline ultrasound Figure 01 to detect any associated malformations, evaluate the contralateral kidney (in case of unilateral renal agenesis), examine the bladder, external genitalia, and urinary tract. In cases of left renal agenesis, an amniocentesis was performed, followed by BHCG analysis to detect microdeletions in the 22q11 region. Genetic counseling was offered in the event of normal amniocentesis results, due to the family history. Additionally, a nephrology consultation was scheduled to discuss postnatal management. The parents also underwent renal ultrasound to assess the presence of anomalies.

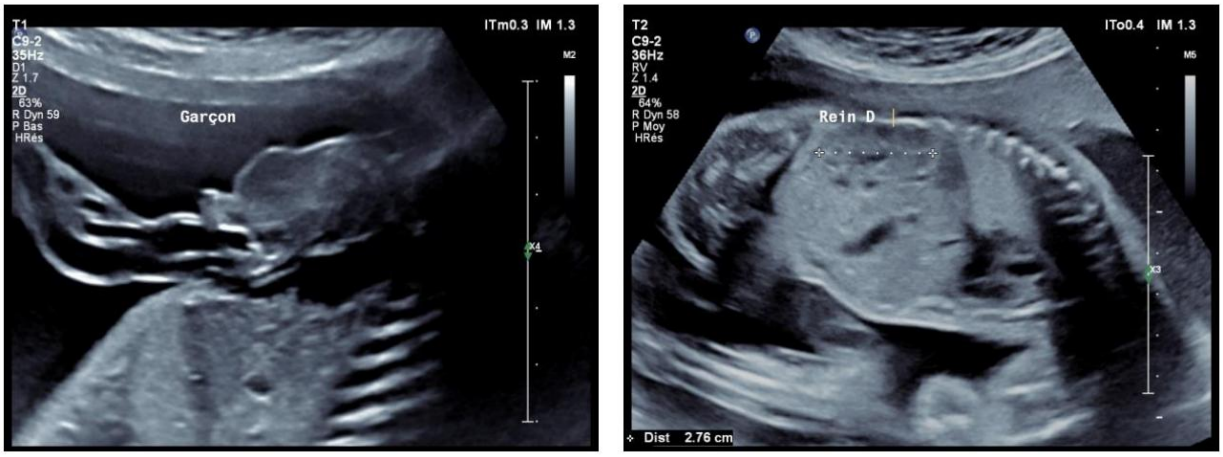


Figure 01: Ultrasound image of a 27-week-old fetus with Unilateral Renal Agenesis

4.1.2 Results

The results of the study revealed a baseline ultrasound showing renal malformations, including left renal agenesis and compensatory right renal hypertrophy. The karyotypes were normal, and the nephrology consultation indicated a good prognosis. The renal ultrasound of the parents showed normal results for the father but left renal ectopia for the mother. At birth, a male infant weighing 3020 g at 40 weeks of gestation was delivered, and the postnatal ultrasound showed results identical to those obtained during the prenatal period.

In light of the results, it was found that unilateral renal agenesis has an incidence of 1 to 4 per 1000 births, with a favorable long-term prognosis if the contralateral kidney exhibits compensatory hypertrophy. The main risk associated with this condition is the development of microalbuminuria. To reassure the parents, periodic ultrasounds should be performed during childhood, with particular attention to monitoring statural growth. A balanced diet, with moderation of protein intake, is recommended. Furthermore, long-term monitoring of blood pressure and microalbuminuria is necessary. In the presence of microalbuminuria, renal protective treatment with angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor antagonists (ARBs) should be considered.

4.2 MEGAURETERS

4.2.1 Data

At the age of 5, the same boy was admitted to the pediatric emergency department due to persistent abdominal bloating since the age of two months. The clinical examination at admission revealed a satisfactory general condition, but significant abdominal bloating was observed. Additionally, a mass was detected occupying the pelvic region. The medical history indicated that the patient had been diagnosed with unilateral renal agenesis during a prenatal ultrasound (Figures 2-4).

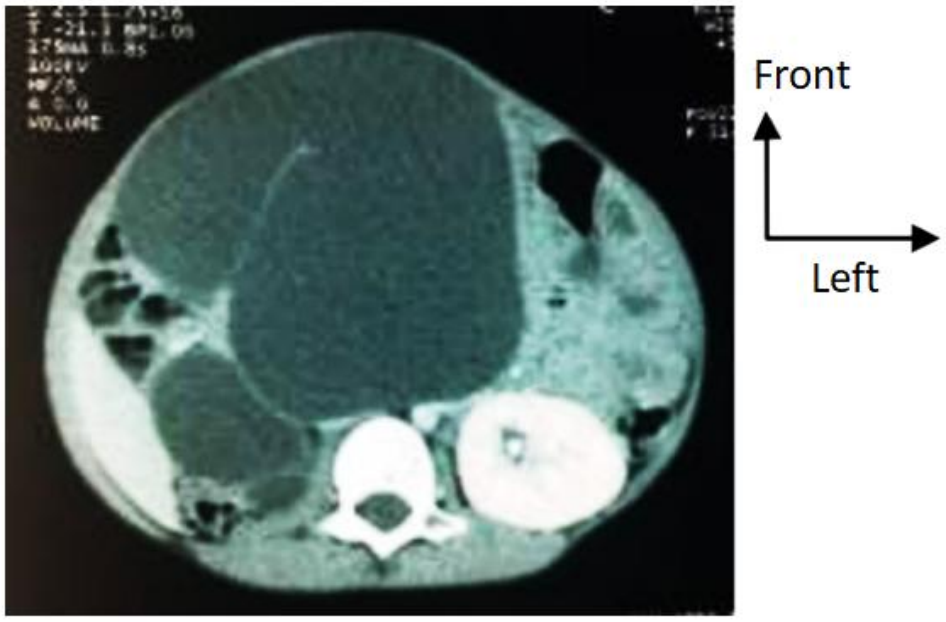


Figure 2: Transverse slices of abdominal CT scan revealing the presence of a fluid-filled mass occupying the pelvic region.

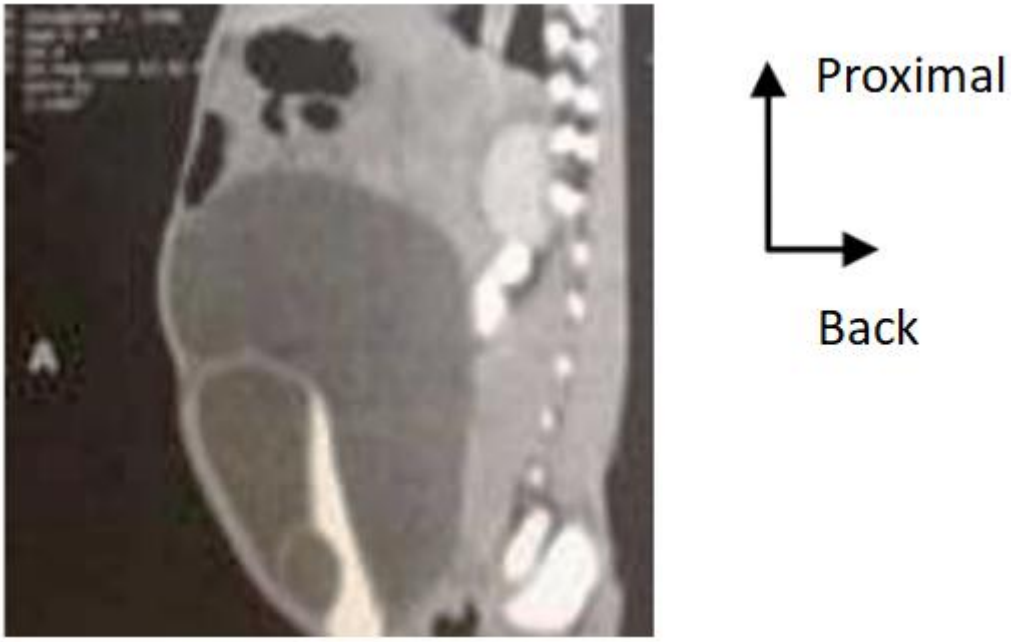


Figure 3: Sagittal slices of abdominal CT scan revealing the presence of a fluid-filled mass occupying the pelvic region.

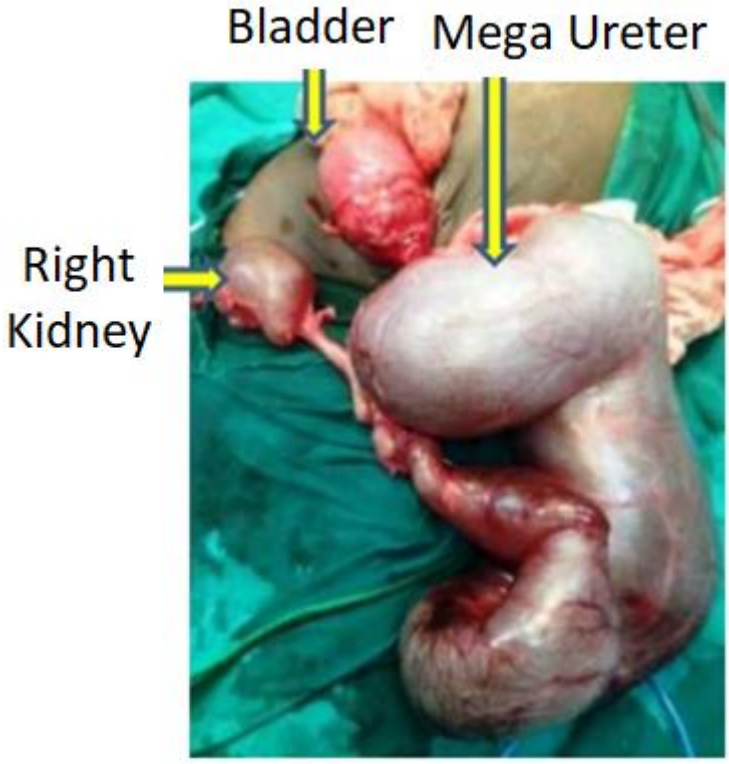


Figure 4: Tortuous megaureter and stenosis of the ureterovesical junction.

4.2.2 Results

An abdominal ultrasound was performed to evaluate the cause of the persistent abdominal bloating. The results confirmed the diagnosis of unilateral renal agenesis, with complete absence of the left kidney. Furthermore, an abdominal computed tomography (CT) scan was performed for a more detailed evaluation. The CT scan results revealed a large right megaureter, complete destruction of the renal parenchyma on the right side, and compensatory hypertrophy of the contralateral kidney.

This case study highlights a 5-year-old boy presenting with megaureter, diagnosed following persistent abdominal bloating since the age of two months. The results of the imaging examinations, including abdominal ultrasound and CT scan, confirmed the presence of a large right megaureter Figure 3. This observation underscores the importance of early and thorough evaluation of urinary malformations, such as megaureter, to determine the appropriate management plan and prevent potential complications.

4.3 Discussion of General Results

This case study highlights a relationship between unilateral renal agenesis, diagnosed in the prenatal period, and the complication of megaureter. The results of imaging examinations, including abdominal ultrasound and CT scan, confirmed the complete absence of the right kidney, the presence of a left megaureter, complete destruction of the left renal parenchyma, and compensatory hypertrophy of the left kidney. This observation underscores the importance of early and thorough evaluation of congenital renal malformations such as unilateral renal agenesis to determine the appropriate management plan and prevent potential complications of megaureter.

5. CONCLUSION

In conclusion, this study highlights the impact of unilateral renal agenesis on the development of complications related to megaureter in patients. The examined case confirmed the correlation between the absence of one kidney and the presence of large megaureters. These results underscore the importance of early and thorough evaluation of congenital renal malformations, enabling appropriate management and prevention of potential complications.

However, further research is needed to better understand the underlying mechanisms of these malformations and to assess the best management strategies. Improved understanding of these

conditions will lead to improved patient care and prevention of potential long-term complications.

Overall, this study contributes to the deepening of knowledge regarding the impact of unilateral renal agenesis on the development of megaureters. It emphasizes the importance of early evaluation, regular follow-up, and tailored management to ensure the health and well-being of patients with these congenital renal malformations.

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