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Citation

Abstract
Objectives: Pediatric Scintigraphy images and their findings are often challenging to perform and interpret. Here, a preliminary teaching atlas of unusual and interesting pediatric abdominal Scintigraphy findings is presented to serve as a reference guide.
Methods: Congenital abdominal Scintigraphy images from interesting and unusual pediatric cases gathered during daily imaging interpretation sessions were selected over the past two years.
Results: Seventeen interesting cases of congenital renal anomalies and choledocal cyst are presented.
Conclusion: This imaging atlas can be used as a teaching file.

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BACKGROUND
Pediatric scintigraphic images and their findings are often challenging to perform and interpret. Among the congenital abdominal anomalies, renal anomalies are most common. Renal Duplication, Renal Ectopia, Solitary kidney, Horseshoe Kidney Polycystic and Multicystic kidneys are the common renal anomalies. Prune-Belly syndrome and Vater syndrome are also associated with renal anomalies. Choledocal cyst is another rare congenital anomaly of extra hepatic biliary tree.

METHODS AND MATERIALS
Images from interesting and unusual abdominal pediatric cases gathered during daily imaging interpretation sessions were selected over the past two years.

RESULTS
Seventeen interesting and unusual case studies are presented. There were 9 girls and 8 boys, ages ranging 3 days to 17 years. The disease entities encountered were various renal anomalies to choledocal cyst as described in cases 1-17.

CASE #1
A 4-month-old baby girl presented with left hydronephrosis. Tc99m MAG-3 renal scintigraphy with lasix demonstrated left kidney duplication with dilated and tortuous ectopic ureter from the upper pole and obstruction in the lower pole with a possible ectopic attachment to the urinary bladder (Figs. 1 a, b).

Figure 1
Figure 1: Left Renal Duplication

Duplication of the ureter and renal pelvis is one of the most common urinary tract abnormalities. It is bilateral in 25 to 30% of patients. The upper pole ureter tends to insert more caudally and medially. Lower pole ureter generally inserts normally.

Reflux is more common in the lower pole ureter and obstruction is more common in upper pole ureter. Tc99m DMSA study is useful to demonstrate the relative function of the duplicated system and Tc99m MAG-3 is helpful to evaluate the obstructive component.

CASE #2
An 11-year-old female with developmental delay presented
with urinary tract infection. Tc99m DMSA renal cortical scintigraphy demonstrated a Horseshoe kidney associated with pyelonephritis and scarring (Fig. 2).

**Figure 2**
Figure 2: Horseshoe Kidney

Fusion in Horseshoe kidneys is usually in lower poles. Children with Horseshoe kidneys usually present with infection, hypertension and hematuria. Radionuclide study with Tc99m DMSA is useful to assess the function, scarring and pyelonephritis of the fused kidney.

**CASE #3**
An 8-year-old male with renal ectopia and bilateral vesicoureteral reflux had a Tc99m DMSA scintigraphy demonstrating crossed fused left kidney with decreased function, scarring and pyelonephritis (Fig. 3).

**Figure 3**
Figure 3: Crossed Fused Left Kidney

Renal ectopia can be unilateral or bilateral. It can present as a crossed fused solitary kidney. Pelvis is one of the locations for ectopic renal kidney. Pelvic kidney requires anterior imaging.

**CASE #4**
A 9-year-old male with Vater syndrome and a solitary left kidney demonstrating scarring in upper and lower poles by a Tc99m DMSA study (Fig. 4).
Vater Syndrome is associated with various non cardiac abnormalities including vertebral, anal, tracheoesophageal, radial and renal anomalies.

**CASE #5**
A 3-day-old neonate baby boy with right Multicystic dysplastic kidney (MCDK) and left hydronphrosis demonstrated on Tc99m MAG-3 study (Figs. 5 a, b).

**CASE #10**
A 2-month-old baby boy with malrotated kidney in utero. Tc99m MAG-3 study demonstrating a small atrophic left kidney with poor perfusion, function and excretion (Figs. 7 a, b).

**CASE #11**
A 1-year-old baby boy with Vater Syndrome and Grade II right Vescicoureteral reflux (VUR) demonstrating dilated and tortuous ureters (Figs. 8 a, b).

MCDK is the most frequent cystic disorder of infants and children. MCDK varies in size and shape and contains non communicating cortical and medullary cysts. Other urogenital abnormalities are common. Tc99m DMSA and Tc99m MAG-3 usually demonstrate no radiotracer uptake in MCDK.
Figure 8
Figure 8: Bilateral Dilated and Tortuous Ureters

Vater Syndrome is associated with major cardiovascular manifestation of Ventricular septal defect and other minor non cardiac abnormalities including vertebral anomalies, anal atresia, tracheo-esophageal fistula, radial and renal anomalies.

CASE # 12
A one-month-old baby boy with Prune Belly Syndrome demonstrating bilateral hydronephrosis on Tc99m MAG-3 study (Figs. 9 a, b).

Figure 9
Figure 9: Bilateral Hydronephrosis

Prune-Belly Syndrome occurs in male infants. It manifests as dilatation of the urinary bladder and ureters with a flabby abdominal wall due to muscular deficiency of unknown etiology. If severe, the neonates die soon after birth or may be still born. The abnormalities associated with the syndrome include pulmonary hypoplasia, renal dysplasia, urethral obstruction, weak chest wall muscles, vesicoureteric reflux, and undescended testes. Dynamic renal imaging demonstrates various findings ranging from normal to dilated pelvicalyceal systems with or without obstruction. Renal cortical imaging assesses the function and scarring.

CASE # 13
A 2-day-old baby girl with solitary left kidney on Tc99m DMSA study (Fig. 10).

Figure 10
Figure 10: Solitary Left Kidney

Displacement of one or both kidneys associated with renal malformations is one of the renal anomalies.

CASE #14
A 3-year-old boy with history of Oxalosis and obstructive nephropathy had large kidneys with decreased function and poor excretion from both kidneys, right worse than left on a Tc99m MAG-3 study (Fig. 11).
Oxalosis is one of the storage diseases of aminoacid metabolism inherited as autosomal recessive trait. Oxalosis is due to widespread deposition of Calcium oxalate in renal and extrarenal tissues. It may manifest during first year of life. Renal colic or hematuria can develop between ages 2 and 10 and uremia can develop before age 20. Large doses of pyridoxine may reduce urinary oxalate temporarily. A diet rich in phosphate may reduce the frequency of renal colic.

CASE # 15
A 2-year-old baby girl with poorly functioning ectopic left kidney demonstrated on Tc99m MAG-3 study (Figs. 12 a, b).

CASE #16
An 18-month-old baby girl with right renal duplication demonstrated on Tc99m MAG-3 study. (Figs. 13 a, b).

Choledocal cyst is a rare abdominal congenital anomaly. It is a congenital dilatation of the extrahepatic biliary tree. There are 5 types of choledocal cysts by Todani Classification. Type I is fusiform dilation of the extrahepatic bile duct. Type II is single secular dilation or diverticulum of the extrahepatic bile duct. Type III is dilation of the intraduodenal portion of the bile duct. Type IVa demonstrates intra and extrahepatic biliary duct dilatation. Type IVb demonstrates multiple dilations of the extrahepatic bile duct. Type V is isolated or diffuse dilatation of the intrahepatic biliary ducts and is called Caroli’s disease when associated hepatic fibrosis. About 15% of these patients have biliary atresia.
CONCLUSION
Various congenital renal anomalies and choledocal cyst with scintigraphic findings are presented. This preliminary imaging atlas may be useful in developing a large atlas in diagnosing and managing congenital pediatric abdominal anomalies and can be used as a teaching file.

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References
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