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PICTORIAL ESSAY

Valeria Rathaus · Miriam Werner · Enrique Freud · Meir Mei-Zahav · Huda Mussaffi · Hanna Blau

Sonographic findings of the genital tract in boys with cystic fibrosis

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Abstract This pictorial review illustrates the findings in the sonographic examination of the male genital tract in children with cystic fibrosis (from newborn to age 12 years). We illustrate the variability in appearance and discuss the differences in findings from those in adult males with cystic fibrosis.

Keywords Cystic fibrosis · Ultrasound · Male genital anomalies · Seminal vesicles · Epididymis · Testis

Introduction

Cystic fibrosis (CF) is a heterogeneous recessive genetic disorder with pathobiological features that reflect mutations in the cystic fibrosis transmembrane conductance regulator gene (CFTR) [1]. CF mainly affects the pulmonary and digestive systems and is most prevalent in Caucasians of northern European descent [1]. Although CF can be fatal in childhood, survival has greatly improved in recent years. Approximately 97% of males with classic CF are sterile because of congenital bilateral absence of the vas deferens (CBAVD), which is associated with anomalies or absence of the seminal vesicles, and defects in derivatives of the Wolffian duct system (absence or atrophy of the distal portion of the epididymis) [2, 3]. In patients with mild mutations, the first and often the only organ to be affected is the male genital tract, which appears to be exquisitely sensitive to defects in the CFTR protein [2]. Reports of genital imaging in the literature are few and only deal with the adult population [2, 4, 5]. We studied a group of 16 boys with CF, newborn to age 12 years, who were followed at Schneider Children's Medical Center of Israel and represent the spectrum of sonographic findings in the male genital tract of children with CF. All sonographic examinations were done as part of routine clinical assessment, and appropriate written informed consent was obtained by the patients' parents in every case. Our findings are compared with those in adult male CF patients.

Sapir Medical Center, Kfar Saba, and Schneider Children's Medical Center of Israel, Petah Tikva, are affiliated with the Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel

V. Rathaus · M. Werner
Diagnostic Imaging Department,
Sapir Medical Center,
Kfar Saba, Israel

E. Freud
Pediatric Surgery Department,
Schneider Children's Medical Center of Israel,
Petah Tikva, Israel

M. Mei-Zahav · H. Mussaffi · H. Blau
Pulmonary Unit
and Kathy and Lee Graub Cystic Fibrosis Center,
Schneider Children's Medical Center of Israel,
Petah Tikva, Israel

V. Rathaus (✉)
Diagnostic Imaging,
Meir Hospital,
Chernikovski St.,
Kfar Saba, 44300, Israel
e-mail: rathaus@bezeqint.net
Tel.: +972-974-71512
Fax: +972-974-71512

Discussion

Seminal vesicles

The seminal vesicles (SVs) are paired, sacculated and coiled structures, lying between the bladder and rectum, and posterior to the base of the prostate gland. Transrectal sonography is the method of choice for the imaging the SVs in adults [6], but in children, the transabdominal sonographic approach in the presence of a full bladder is preferred because it is a noninvasive imaging method [7]. Visualization of the seminal vesicles is possible by transabdominal US in about half of healthy children [7]. We visualized SVs in about half of the children with CF examined (Fig. 1). This is in accordance with a pathological study done in 15 CF infants where normal seminal vesicles were found in about half of the autopsies [8]. In

contrast, in the adult CF population, SV abnormalities are observed in 90% of the patients, and these glands are completely absent in approximately 50% of the patients [9]. Entirely normal seminal vesicles were found in fewer than 10% of adults with CF [4]. This apparent progression of pathology with age supports the concept that CBAVD is an acquired lesion rather than a congenital defect, possibly because of an accumulation of thick secretions and subsequent obstruction of the lumen [10].

Epididymis

Anomalies of the epididymis are commonly present in CF patients (both children and adults), and this might be the primary site of insult. The available literature only describes the findings of autopsies or surgical explorations [11, 12]. We found variability in the sonographic appearance of the epididymal head in these children: (1) diffuse hyperechogenicity (Fig. 2); (2) hypoechoic lesion (Fig. 3); (3) epididymal cyst (Fig. 4); (4) inhomogeneous texture (Fig. 5).

Testis

The testes have been evaluated for their volume and parenchymal texture.

Volume

Testicular volume has been considered to correlate with testicular function. The volume of the testes in CF boys in our series was slightly smaller than predicted for the chro-

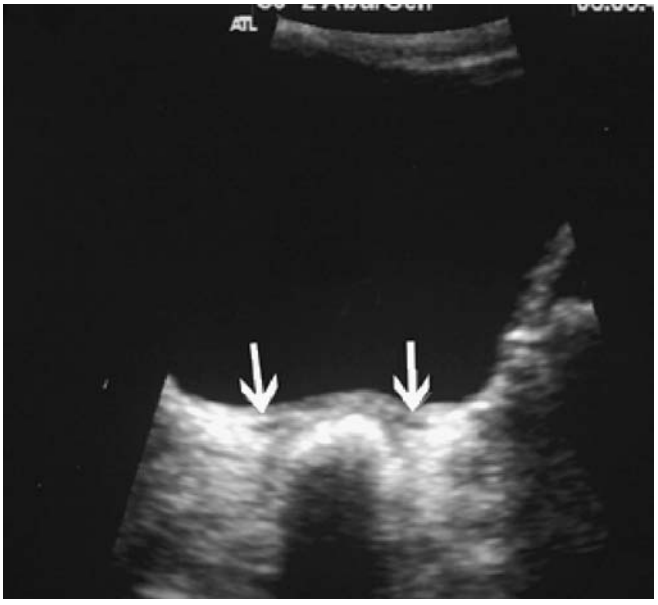

Fig. 1 Visualization of seminal vesicles in a 6-year-old boy. Transverse scan of the urinary bladder. Normal-appearing seminal vesicles are seen as a pair of oval hypoechoic structures (*arrows*) at the base of the full bladder

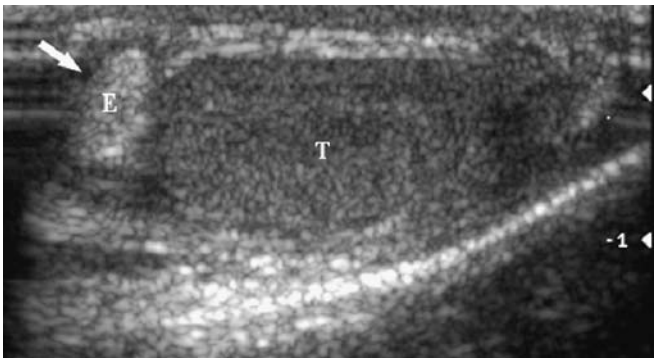

Fig. 2 Epididymal head: hyperechoic appearance in a 6-year-old boy. Longitudinal scan of the right hemiscrotum. A hyperechoic head (*arrow*) of the epididymis (*E*) is seen. Note that the head of epididymis is more echogenic than the testis (*T*)

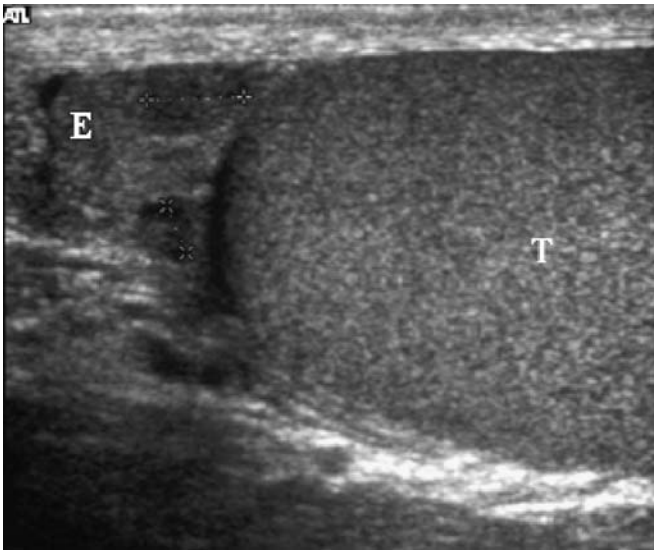

Fig. 3 Epididymal head: hypoechoic area in a 7-year-old boy. Longitudinal scan of the right hemiscrotum. Two hypoechoic areas (*arrows*) with some slight echogenic foci are seen in the head of the epididymis (*E*)

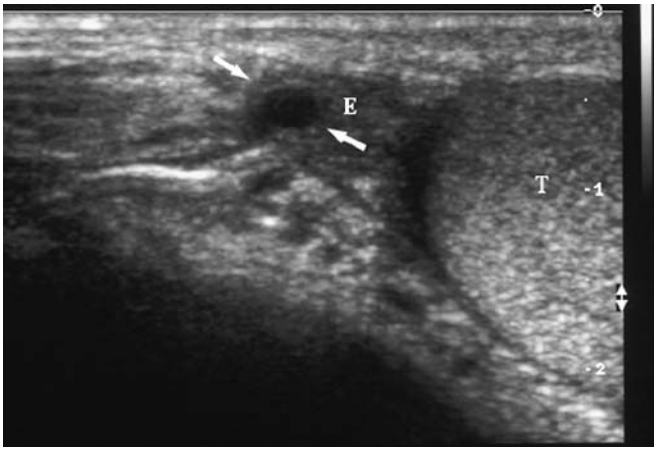

Fig. 4 Epididymal head: cystic lesion in a 7-year-old boy. Longitudinal scan of left hemiscrotum. A well-defined anechoic area (*arrows*) without posterior enhancement is shown in the head of the epididymis (*E*)

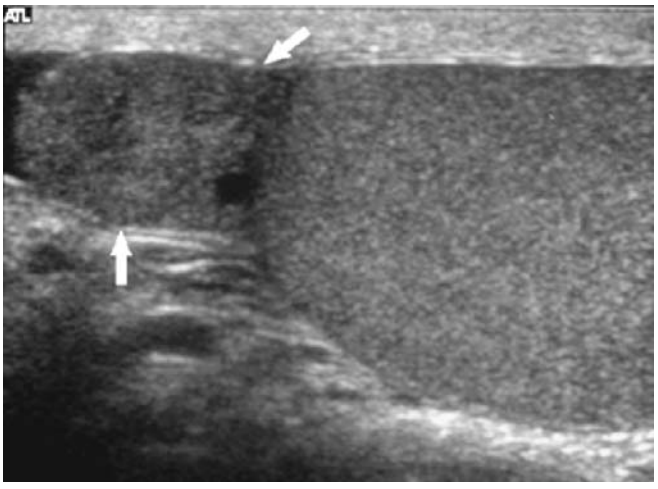

Fig. 5 Epididymal head: non-homogeneous appearance in a 9-year-old boy. Longitudinal scan of the right hemiscrotum. The head of epididymis (*between the arrows*) shows a non-homogeneous texture with ill-defined areas of different echogenicity

nological age [13]. This finding is in agreement with the testicular volume measured in a CF adult population [2] and with the pathological findings in children [11].

Calcifications

We recognized three types of testicular parenchymal calcifications in the boys with CF. Interestingly, in all cases where increased echogenicity was identified in the testicular tissue, no posterior acoustic shadow was found. We speculate that these echogenic foci represent inspissated secretions rather than actual calcification, and that might calcify later in life. The three types of calcifications recognized were:

1. Microcalcifications. We found a few small non-shadowing hyperechoic foci, up to 3 mm in diameter (Fig. 6) in an otherwise normal testicular parenchyma in 7 out of 12 children with CF. These findings are likely to represent microcalcifications and might be a result of inspissated secretions in the seminiferous tubules, which then became obliterated. In children, testicular microcalcifications have been described in association with tumors such as feminizing Sertoli cell tumors [14]. However, in the presence of a diagnosis of CF, further investigations are not indicated. In adults, the presence of a few hyperechoic foci or a solitary punctate calcified focus are usually considered to be of vascular origin or a result of spermatic granulomas [15].
2. Microlithiasis. Although testicular microlithiasis (TM) is rarely seen in healthy children [16] and is quite rare in otherwise healthy adult men (1% of the population) [17], it is a frequent finding in adult males with CF [5]. This manifestation has not been described in children with CF. In the present series, TM was found in various grades of severity (Fig. 7). The differential diagnosis of TM in children, in addition to CF, includes the Klinefelter syndrome, cryptorchidism, Down syndrome, pulmonary alveolar microlithiasis, male pseudoher-

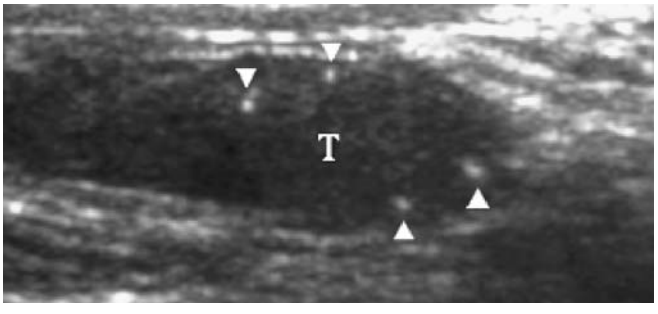

Fig. 6 Testicular microcalcifications in a 3-year-old boy. Longitudinal scan of the left testis. A few small hyperechoic foci (*arrowheads*) are seen in the parenchyma of the testis (*T*)

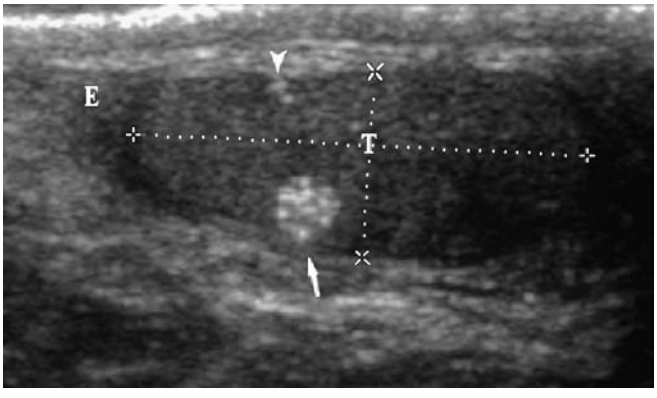

Fig. 8 Coarse testicular calcification in a 5-year-old boy. Longitudinal scan of the right hemiscrotum. A coarse round hyperechoic area (compatible with a conglomerate of microcalcifications) (*arrow*) in seen in the testis (*T*), without posterior acoustic shadow. Two small foci of microcalcifications (*arrowhead*) are also present

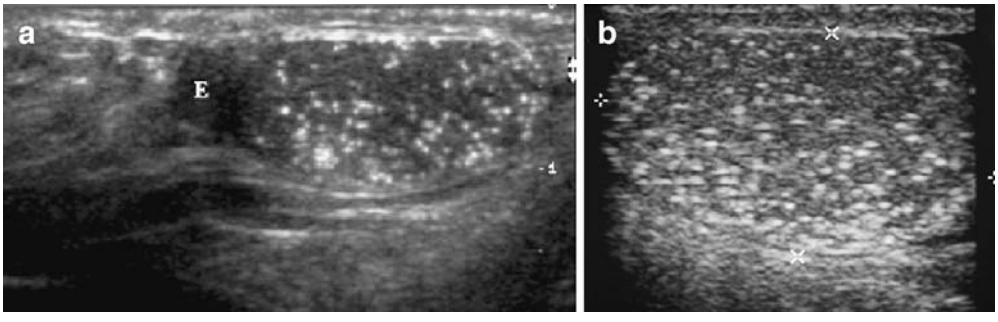

Fig. 7 Testicular microlithiasis. **a** Longitudinal view of the right hemiscrotum in a 7-year-old boy. Multiple small hyperechoic foci are seen in the parenchyma of the testis. No posterior acoustic shadow is seen (*E* head of epididymis). **b** Longitudinal view of the left hemiscrotum in a 9-year-old boy. Small multiple hyperechoic foci are scattered in the testicular parenchyma

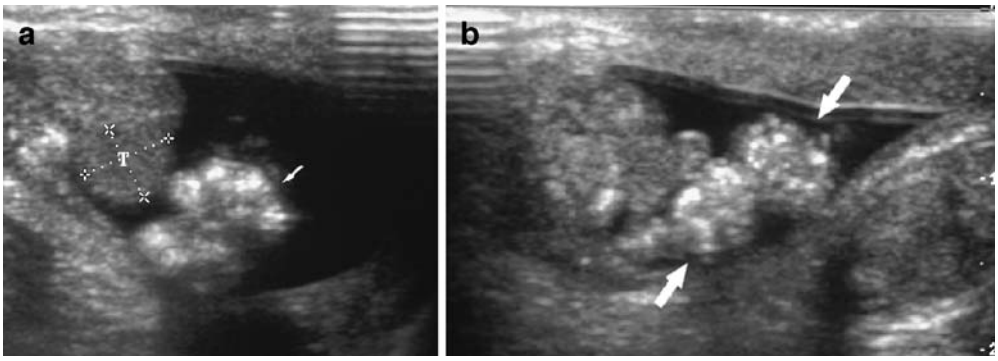

Fig. 9 Meconium periorchitis in a newborn. **a** Oblique view of the right hemiscrotum. The hyperechoic masses are seen caudally to the normal testis (*T*) and floating in the hydrocele. **b** Oblique view of the lower part of the right hemiscrotum (same patient). The floating hyperechoic masses (*arrows*) are shown surrounded by fluid

maphroditism, previous radiotherapy, and subfertility states and, most important, testicular neoplasms [18].

3. Coarse shadowing calcifications. An extensive localized area of coarse calcification without a posterior acoustic shadow in the testicular parenchyma and not associated with a soft-tissue mass was identified in one child in our series (Fig. 8). This type of calcification has been described in adults as a result of inflammatory scars, granulomas, and infarction with hemorrhage [19], as well as a so-called burned-out tumor, which is considered to represent a regressed testicular tumor [20]. A connection between this finding and CF in young males has not been previously described.

Scrotal calcifications

Scrotal calcifications have been described in children with CF. These calcifications seem to represent calcified meconium, known as meconium periorchitis (MPO). This entity is considered an uncommon cause of calcified scrotal extratesticular calcifications [21, 22] and is associated with healed meconium peritonitis caused by intrauterine bowel perforation secondary to meconium ileus. MPO is caused by the passage of meconium into the scrotum through a patent processus vaginalis [21]. Sonographically, MPO causes a well-defined scrotal mass that envelops the testes and epididymis with echogenic shadowing the foci of calcifications (Fig. 9). Sometimes, MPO appears as small calcifications within the tunica vaginalis (Fig. 10). Abdominal radiographs might demonstrate peritoneal calcifications or calcification in the scrotal or inguinal region in as many as 90% of cases of meconium peritonitis (Fig. 11) [22]. In some cases, the sonographic examination of the abdomen discloses peritoneal calcifications (Fig. 12). Peritoneal calcifications are considered diagnostic for meconium peritonitis, but other conditions should be considered in the differential diagnosis in patients who

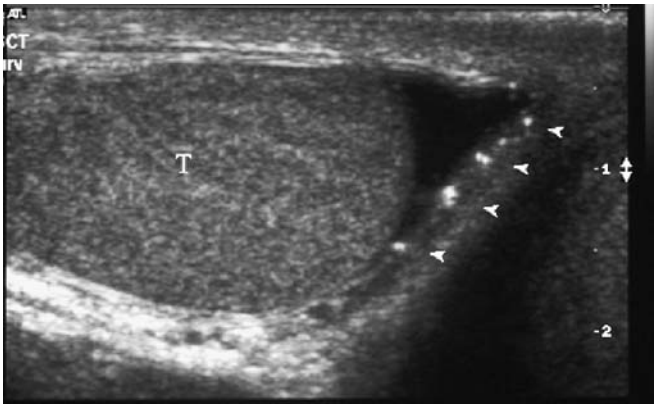

Fig. 10 Meconium periorchitis in a 4-year-old boy. Longitudinal view of the right side of the scrotum. Multiple hyperechoic foci (*arrowheads*) are present in the tunica vaginalis. The caudal part of the normal testis (*T*) is seen surrounded by a small amount of fluid

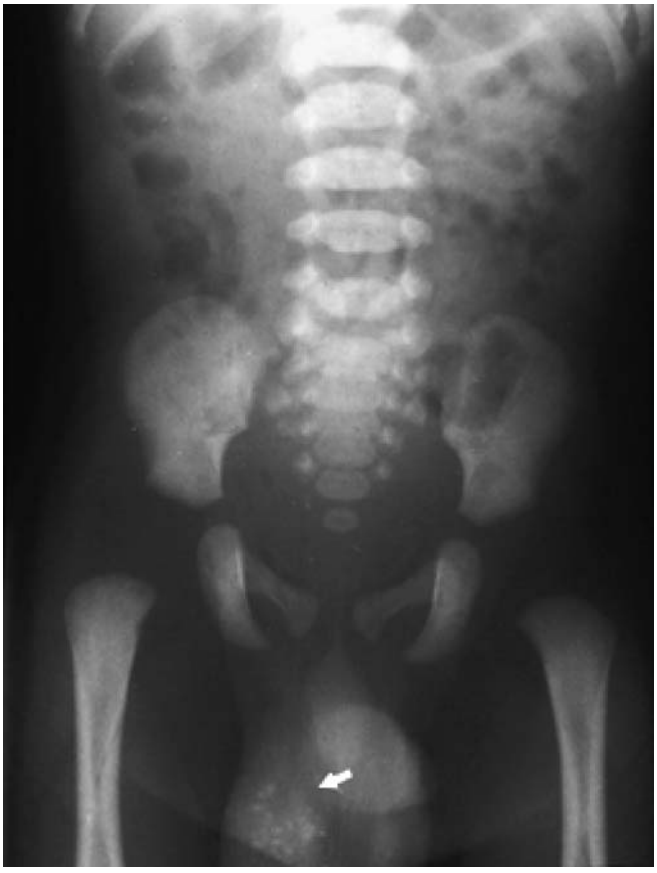

Fig. 11 Meconium periorchitis in a newborn, the same patient as in Fig. 9. Supine radiography of the abdomen and pelvis. Multiple small calcifications (*arrow*) are seen in the right scrotal region. No calcifications are present in the abdomen

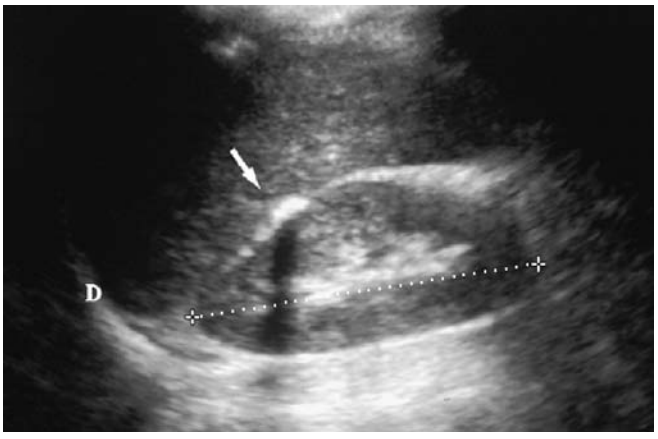

Fig. 12 Calcifications caused by meconium peritonitis in a 4-year-old boy (same patient as in Fig. 10). Longitudinal US scan of the right abdomen. Hyperechoic foci (*arrow*) compatible with calcifications are present between the right normal kidney (*between the cursors*) and the liver (*D* right diaphragm)

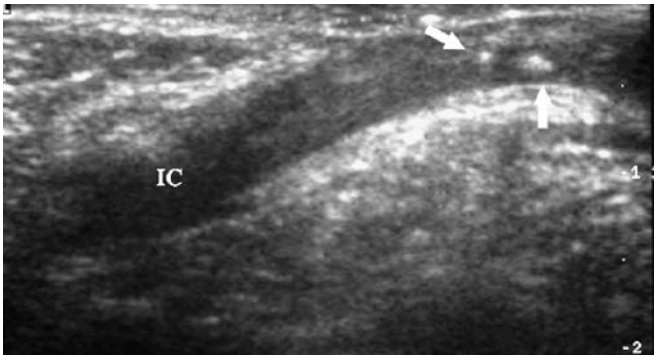

Fig. 13 Calcifications of meconium in the inguinal canal in a newborn (same patient as in Fig. 9). Longitudinal scan of the right inguinal canal. Two small hyperechoic foci (*arrows*) are shown in the inguinal canal (*IC*). These foci represent calcifications of meconium

do not have CF, such as teratoma, gonadoblastoma, torsion and infarction of the testis, calcifying Sertoli cell tumor and metastatic neuroblastoma [21]. The diagnosis of MPO might be reached with more confidence in the presence of calcifications in the inguinal canal (Fig. 13), even if abdominal calcifications are absent.

Conclusion

There are a variety of imaging findings in the male genital tract of children with CF, and these have not been described previously. The recognition of these features could play a key role in confirming the diagnosis of atypical cases. Such children might have strongly suggestive pulmonary disease but normal pancreatic function, unidentified genetic mutations and a normal or borderline sweat test.

Because we found that US examination of the genital tract in male children with CF could be normal, particularly in atypical CF with mild mutations, even as infertility is almost ubiquitous in adulthood, it appears that genital lesions might develop at a later stage. As this is a non-invasive examination, we recommend that US evaluation be repeated every few years. These studies might delineate the evolution of disease in the CF male genital tract and enable timely intervention as future therapies become available.

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