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Authors
Basta, Amaya M
Courtier, Jesse
Phelps, Andrew
et al.

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Scrotal Swelling in the Neonate

Amaya M. Basta, MD, **Jesse Courtier, MD**, **Andrew Phelps, MD**, **Hillary L. Copp, MD, MS**, and **John D. MacKenzie, MD**

Department of Radiology, Oregon Health & Science University, Portland, Oregon USA (A.M.B.); and Departments of Radiology and Biomedical Imaging (J.C., A.P., J.D.M.) and Urology (H.L.C.), University of California, San Francisco, Benioff Children's Hospital, San Francisco, California USA.

Abstract

Discovery of scrotal swelling in a neonate can be a source of anxiety for parents, clinicians, and sonologists alike. This pictorial essay provides a focused review of commonly encountered scrotal masses and mimics specific to the neonatal setting. Although malignancy is a concern, it is very uncommon, as most neonatal scrotal masses are benign. Key discriminating features and management options are highlighted to improve the radiologist's ability to diagnose neonatal scrotal conditions and guide treatment decisions. Neonatal scrotal processes ranging from common to uncommon will be discussed.

Keywords

genitourinary ultrasound; neonatal scrotal tumor; neonatal testicular mass; pediatric ultrasound; scrotal mass; scrotal sonography; scrotal swelling

Discovery of an apparent scrotal mass is a common occurrence in neonates, and a comprehensive understanding of the presentation and imaging appearance is important to help guide medical and surgical management. These patients often present clinically with nonspecific signs such as scrotal swelling and discoloration, leading imaging to play a key role in management.[1,2] Causes of a scrotal "mass" on clinical examination of a neonate may be related to lesions that are either intratesticular or extratesticular. Processes that involve the neonatal testicle include torsion, neoplasms, supernumerary testis (polyorchidism), splenogonadal fusion, and adrenal rests. Scrotal lesions external to the testicle such as hematoma, hydrocele, inguinal hernias, and extensions of generalized processes can also present clinically as masses. Because these entities constitute a diverse group with widely varied management options, timely and accurate diagnosis is essential.

Sonography is the imaging modality of choice for noninvasive assessment of the scrotum and guidance with further medical and surgical management. A combination of grayscale

and color Doppler sonography (with pulsed Doppler imaging when needed, if possible) is a safe, fast, and effective tool to examine the scrotum and its contents. Magnetic resonance imaging is reserved for neonates in whom the sonographic findings are equivocal, although sedation or anesthesia, as well as an intravenous contrast agent, may be necessary. Therefore, the aim of this pictorial essay is to review the imaging appearance of several scrotal masses and mimics encountered in the neonate, from common to uncommon, with an emphasis on sonographic findings, and to present an overview of management options.

Testicular Etiologies of Scrotal Swelling in the Neonate

Neonatal Testicular Torsion

In testicular torsion, twisting of the testis around its vascular pedicle (the spermatic cord) results in compromised lymphatic, venous, and arterial flow to the ipsilateral testis and epididymis (Figure 1), which can result in ischemia, infarction, and subsequent necrosis.

The tunica vaginalis, a serous membrane that arises from the processus vaginalis of the peritoneum, normally covers the testicle and epididymis except posterolaterally, where it attaches to the testis on either side of the epididymis (Figure 1A).[1,3,4] The inferior pole of the testis, with its tunica vaginalis covering, is normally anchored to the scrotal wall by the gubernaculum testis, or scrotal ligament. Extravaginal torsion (Figure 1C) occurs in fetuses and neonates because of the loose attachment between the tunica vaginalis and scrotal wall (via the gubernaculum testis) early in life, allowing the tunica vaginalis and its contents to twist together around the axis of the spermatic cord. Normally, these attachments strengthen as the infant grows and are fully developed by around 3 months of age, making extravaginal torsion a condition of early infancy.[4,5]

In contrast, intravaginal torsion (Figure 1D) usually occurs in the setting of a typically bilateral anatomic variant called the "bell clapper deformity." In this variant, the tunica vaginalis (which completely encases the testis, epididymis, and distal spermatic cord) has an abnormally high attachment onto the spermatic cord and lacks attachments to the scrotal wall (Figure 1B).[3] This condition permits free rotation of the testis, epididymis, and spermatic cord within the tunica vaginalis.[1] This disease generally occurs in older children and adults. Although intravaginal torsion can occur in infancy, it usually happens after 1 month of age.[6]

Approximately 10% of all testicular torsions occur in neonates, and nearly all of these are the extravaginal type.[4,5,7] Of these, more than 70% are thought to occur in utero, with the remaining 30% occurring in the first 30 days of postnatal life.[4,8] Neonatal testicular torsions do not favor one testicle or the other.[4,7,8] Bilateral torsions have been reported in more than 10% of cases, usually occurring in a synchronous fashion.[2,4,7,9] Although the cause is unknown, testicular torsion in the neonate is associated with full-term birth, vaginal delivery, breech presentation, and birth trauma.[4,8]

Sonographic features of testicular torsion (Figures 2–4) have been well described by Traubici et al[5] and present a stepwise progression as injury to the testicle evolves from ischemia to infarction. In the acute phase, the affected testicle appears enlarged and

heterogeneous in echo texture, often is surrounded by a hydrocele, and shows diminished or absent color Doppler blood flow.[1,5] As injury progresses, the testicle returns to normal size but remains heterogeneous and may show hyperechogenicity in the periphery, consistent with calcifications. Ultimately, testicular atrophy ensues.[5]

The management of neonatal testicular torsion remains controversial and depends on whether the testicular torsion occurred in the prenatal or postnatal setting.[7,10] In neonates found to have a torsed testicle at birth, the torsion event typically occurred before or during birth; therefore, even with prompt treatment after recognition on physical examination, irreversible ischemic damage to the testis likely has already occurred. Because the rate of salvage of a prenatally torsed testis is low, at our institution, often the only treatment offered is reassurance. Interestingly, most (60%) of recently surveyed pediatric urologists state that they would operate on such patients emergently or urgently, and most would perform orchiopexy of the contralateral testis, despite the fact that most prenatal torsions are not related to the anatomic variant (bell clapper deformity) that predisposes to future contralateral torsion.[7,10] Postnatal torsion, conversely, is generally regarded as a surgical emergency, and 93% of respondents would perform immediate surgery in this setting, not only to attempt to salvage the affected testis but also to perform orchiopexy on the contralateral testis.[10] Again, orchiopexy of the contralateral testis is not performed because of an increased risk of torsion but rather because the consequences of anorchia, if torsion were to also occur in the contralateral testis, are devastating.

Outside the neonatal setting, the management of testicular torsion is not as controversial; intravaginal testicular torsion occurring in older children and adults is managed with immediate surgery, as irreversible ischemic injury to the testicle begins 4 hours after onset.

Testicular Neoplasms

Testicular neoplasms are uncommon in children, accounting for only 1% to 2% of solid tumors in boys, and are even less common in the neonatal period.[2] These tumors are divided into 2 groups: germ cell tumors (such as yolk sac tumors, teratomas, and epidermoid cysts) and stromal tumors (including juvenile granulosa cell tumors). Germ cell tumors are overall far more common than stromal tumors, with teratomas and yolk sac tumors being the most common. Teratomas (Figure 5) can occur in the neonatal period, although these have an average age of presentation of 18 months.[11] Yolk sac tumors are the overall second most common, most presenting at younger than 2 years.[12] In older children, assessment of serum markers, including α-fetoprotein (AFP), β-human chorionic gonadotropin (β-hCG), and lactate dehydrogenase, is routine and aids not only in diagnosis but also in prognosis and risk stratification.[13] α-Fetoprotein levels are typically much higher in yolk sac tumors than in teratomas (with levels typically <100 ng/mL); however, it should be noted that overlap exists in AFP serum levels in infants younger than 6 months with these tumor types, given the normal physiologic elevation of AFP in infants, making interpretation more challenging.[14] Although very rare, juvenile granulosa cell tumors (Figure 6) are overall the most common testicular tumors in infants younger than 6 months, and they are uniformly benign.[15–19] Although juvenile granulosa cell tumors lack accompanying endocrine abnormalities, a minority of cases are associated with both abnormal external genitalia and

an abnormal karyotype.[15,16] Sonographically, this tumor had a multiseptated cystic appearance with a hypervascular rim on Doppler interrogation.[15,19] Differential considerations include cystic dysplasia of the testicle (which lacks a solid component and therefore should lack hypervascularity), a teratoma (uncommon in neonates), a yolk sac tumor, a Sertoli cell tumor, and paratesticular masses such as sarcoma.[19] Overall, definitive preoperative diagnosis of a juvenile granulosa cell tumor is challenging, although a combination of a multiseptated cystic and solid mass with negative AFP and β-hCG results can be suggestive of the diagnosis.

If a neoplasm is suspected in a neonate (and in any prepubertal child in general), testis-sparing surgery is attempted due to the higher likelihood of a benign histologic type, and preoperative sonography can be pivotal in guiding surgical management.[20] For example, visualization of characteristically benign sonographic features (such as the "onion skin" appearance specific for an epidermoid cyst) is reassuring as surgery is planned. Likewise, if preoperative sonography shows that a lesion is discrete and does not appear to encompass the entire testis, the testis is delivered through an inguinal incision, and enucleation of the tumor or partial orchiectomy with salvage of the remaining testis is performed. A frozen pathologic section often is sent at the time of surgery to help inform the surgeon and increase confidence that the mass is consistent with a benign neoplasm. In the absence of a reassuring (or diagnostic) frozen section, complete orchiectomy is usually the treatment of choice.[20] Although no clear guidelines exist regarding follow-up for these patients in the long term, given the relative rarity of these tumors, postoperative follow-up is recommended for these patients, particularly in tumors that contain high mitotic figures or that are less well differentiated.[18]

Supernumerary Testicle

The presence of more than 2 testes, referred to as polyorchidism (Figure 7), is a rare congenital anomaly, with fewer than 100 cases reported in the literature.[21,22] This condition is theorized to occur as a result of division of the genital ridge, mesonephros, or testis during embryogenesis.[22,23] The most common variety is triorchidism.[22] The supernumerary testicle is more often left sided, may be orthotopic (scrotal) or ectopic (inguinal or abdominal) in location, and is usually smaller than the other contralateral and ipsilateral testes.[21–23] Polyorchidism is usually discovered incidentally.[21] Associations include cryptorchidism (50%), an indirect inguinal hernia (30%), torsion (at least 10%), and malignancy (≈7%).[21–23] The supernumerary testis may or may not be connected to the epididymis or have reproductive potential.[21,22] In the absence of torsion or malignancy, the imaging characteristics of the supernumerary testicular tissue mirror those of the normal testes.

Splenogonadal Fusion

A quite rare entity, splenogonadal fusion (Figure 8) is a much less common cause of a scrotal mass in the neonate and can be identified incidentally much later in life. Splenogonadal fusion results from fusion of splenic and gonadal elements during development.[24] Reported cases are almost entirely on the left side. Preoperative diagnosis can be challenging, although technetium Tc 99m sulfur colloid scans have been described as having utility in identification of splenic elements.[25,26]

Adrenal Rests

Adrenal rests (Figure 9), which are present in approximately 10% of neonates, are composed of aberrant adrenal tissue retained ectopically within the gonads during embryonic development.[1,2] These present as masses, are typically benign, and can be seen in the setting of congenital adrenal hyperplasia.[1,2] Frequently bilateral, adrenal rests appear sonographically as eccentrically located hyper-echoic or hypoechoic lesions, which may show posterior acoustic shadowing and may be multifocal.[1,2] On pathologic examination, they have a deep yellow color and textural characteristics of adrenal tissue.

Extratesticular Etiologies of Scrotal Swelling in the Neonate

Patency of the processus vaginalis, which is present in 90% of neonates, allows for communication between the peritoneal cavity and the scrotum.[27] This condition forms the basis for many of the following extratesticular causes of scrotal swelling.

Scrotal Hematoma

Masslike enlargement of the scrotum may be due to blood products (Figure 10). Factors that predispose a neonate to hemorrhage within the scrotum include high birth weight, birth trauma, bleeding diathesis, hypoxia, and sepsis; the latter two are also risk factors for adrenal hemorrhage.[28] When a scrotal hematoma is diagnosed, it is essential to evaluate the abdomen and retroperitoneum to exclude either extension of hemorrhage from the abdomen througha patent processus vaginalis or along the retroperitoneum into the scrotum from adrenal hemorrhage or another retroperitoneal structure.[27,28] Scrotal hematomas generally are observed clinically and do not require surgical evacuation.

Hydrocele

A very common cause of scrotal swelling is hydrocele, a fluid collection around the testicle within the tunica vaginalis.[29] When arising in the setting of a patent processus vaginalis (and thus in communication with the peritoneal cavity), it is called a communicating hydrocele; otherwise, it is a noncommunicating hydrocele.[29] Hydrocele fluid can be simple,complex, or chronic. Simple hydroceles (Figure 11) are composed of anechoic fluid on sonography and are very common causes of scrotal swelling in the neonate and infant. Complex hydroceles (Figure 12) contain more heterogeneous and evolving components such as pus (as in a pyocele) or blood (as in a hematocele). The predisposing factors for hematocele, or scrotal hematoma, are discussed above. A pyocele can result from seeding of the scrotum from an intraperitoneal infection, secondary infection of a hydrocele, or hematogenous spread of infection.[30]

A less common entity is a spermatic cord hydrocele (Figure 13), which can be of either the encysted or funicular subtype depending on the absence or presence of a connection with the peritoneal cavity, respectively. In either case, fluid does not communicate with the tunica vaginalis.[31]

From a surgical perspective, scrotal hydroceles in prepubertal patients are almost always considered to be of a communicating origin and often spontaneously resolve in the first year

of life; however, if a communicating scrotal or spermatic cord hydrocele persists beyond 12 to 18 months, it is typically repaired surgically.[29,31] Noncommunicating scrotal and spermatic cord hydroceles, including complex ones, can also spontaneously resolve, and if they persist beyond 1 year of age, they are generally repaired.[29,31]

Inguinal Hernias

Inguinal hernias (Figure 14) are common in boys and are especially prevalent in premature neonates.[29] Bowel enters the scrotal sac via a patent processus vaginalis, more commonly on the right side.[29] Grayscale and color Doppler sonography can be used to evaluate reducibility and the blood supply to the hernia (to exclude incarceration and strangulation). To more completely evaluate a patient with equivocal findings in the supine position, it may be informative to scan the groin and the course of the spermatic cord while supporting the patient in the upright position (without and with the Valsalva maneuver when possible). When an inguinal hernia is diagnosed, semiur-gent surgery usually is performed to prevent the theoretical risk of incarceration.[32,33]

Although sonography can be used to screen the contralateral groin for an occult hernia or a patent processus vaginalis, the clinical impact of incidentally identifying a patent processus vaginalis is questionable.[32,33] Because most patients with this finding will never develop a clinically important hernia, many surgeons will not offer prophylactic repair.

Extensions of Generalized Processes

A number of additional extratesticular causes can result in an apparent scrotal mass. A patent processus vaginalis can permit intra-abdominal free air to enter the scrotum, as in this case of necrotizing enterocolitis (Figure 15). Meconium periorchitis (a consequence of in utero bowel perforation) and lymphatic malformations are also described causes of scrotal masses.[34,35] Other entities such as Henoch-Schönlein purpura (small-vessel vasculitis) are rarer in the neonatal period, more commonly occurring in the 2- to 8-year age range.[36]

Conclusions

We have reviewed the spectrum of etiologies for scrotal swelling in neonates, demonstrating that an apparent scrotal mass on clinical examination may be related to a number of mostly non-neoplastic intratesticular and extratesticular etiologies. Intratesticular processes, including torsion, neoplasms, supernumerary testis (polyorchidism), splenogonadal fusion, and adrenal rests, in addition to numerous etiologies external to the testicle, such as hematoma, hydrocele, inguinal hernias, and extensions of generalized processes, can all clinically mimic solid scrotal masses. Furthermore, when a testicular neoplasm is suspected in the neonate, the differential considerations differ from those of an older child, and a juvenile granulosa cell tumor should be a top consideration, as it is the most common testicular tumor in infants younger than 6 months. Timely and accurate diagnosis of scrotal conditions in a neonate is essential to guide treatment decisions, and grayscale combined with duplex/color Doppler sonography plays a key role.

Acknowledgments

Abbreviations

AFP	α-*fetoprotein*
hCG	human chorionic gonadotropin

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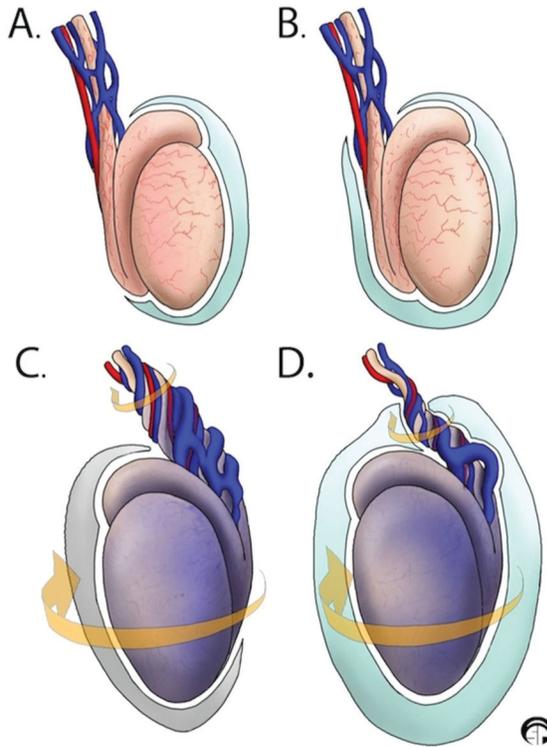
Figure 1.
A, Normal testicular anatomy. The tunica vaginalis (light blue-green) normally covers the testicle and epididymis except posterolaterally, where it attaches to the testis on either side of the epididymis. **B**, Bell clapper deformity. The tunica vaginalis (light blue-green) completely encases the testis, epididymis, and distal spermatic cord and has an abnormally high attachment onto the spermatic cord. **C**, Extravaginal testicular torsion. The tunica vaginalis and its contents twist together around the axis of the spermatic cord. **D**, Intravaginal testicular torsion. The testis, epididymis, and spermatic cord rotate within the tunica vaginalis. Illustrations created by Andrew Phelps, MD, using Photoshop (Adobe Systems, San Jose, CA).
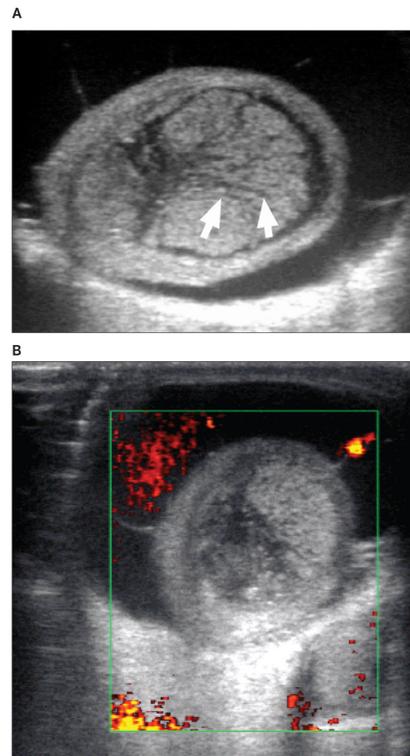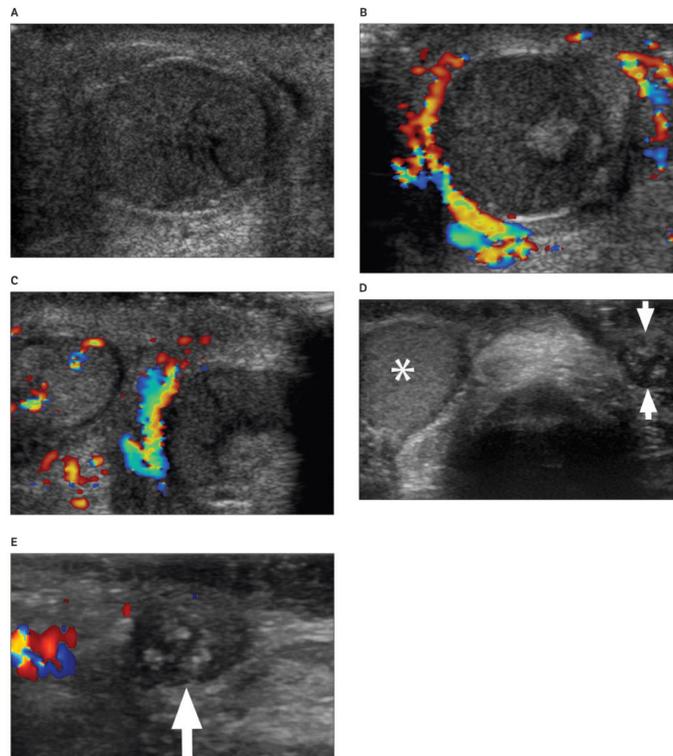
Figure 2.
Neonatal testicular torsion. **A**, Longitudinal grayscale sonogram of the testicle in a 3-day-old boy presenting with a firm swollen testicle with bluish discoloration of the scrotum. The image shows heterogeneous central necrosis of the testicle, mimicking the appearance of a mass. Note the hypoechoic striations (white arrows) within the central testicle. **B**, Transverse power Doppler image in the same patient showing complete absence of vascular flow to the testicular parenchyma. Pathologic examination showed a necrotic testicle.
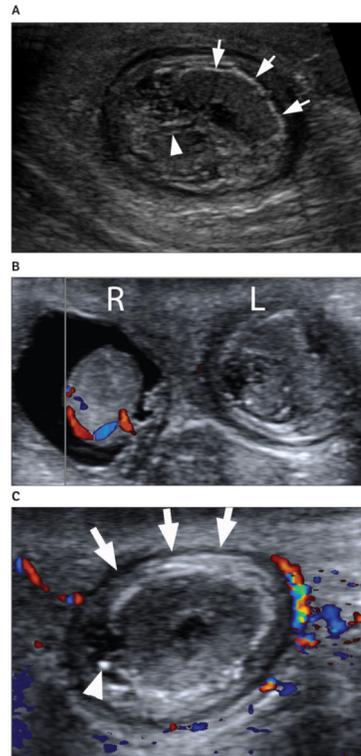
Figure 3.
Neonatal testicular torsion. **A**, Transverse grayscale sonogram of the testicles in an 8-day-old boy with an enlarged, firm left testicle, which was appreciated at his first well-child checkup. The image shows a large heterogeneous left testicle with rim (white arrows) and parenchymal (white arrowhead) calcifications. Note diffuse scrotal wall thickening. **B**, Transverse color Doppler image of the testicles in the same patient showing complete absence of vascular flow to the left testicular parenchyma (L). Blood flow within the right testis (R) is normal. **C**, Longitudinal color Doppler image of the left testis in the same patient showing a large avascular testicle with rim (white arrows) and parenchymal (white arrowhead) calcifications. Emergent left inguinal orchiectomy was performed, and pathologic examination revealed an infarcted testicle.

Figure 4.
Neonatal testicular torsion. **A**, Longitudinal grayscale sonogram of the left testicle in a 1-day-old term neonate presenting with a swollen, firm, nontender left testicle at birth. The image shows an enlarged, heterogeneous, edematous left testis. **B**, Transverse color Doppler image of the left testicle in the same patient showing complete absence of parenchymal blood flow. **C**, Transverse color Doppler image of both testes in the same patient showing an enlarged, heterogeneous, edematous, avascular left testis (LT). The right testicle shows a normal size, echo texture, and blood flow. **D**, Transverse grayscale follow-up sonogram of both testes in the same patient at 6 months of age showing a small calcified left testis (white arrows), consistent with a history of neonatal testicular torsion. The right testicle (white asterisk) is normal. **E**, Longitudinal color Doppler image of the left testicle in the same patient showing a tiny, avascular, calcified testicular remnant (white arrow).

Figure 5.
Teratoma. Longitudinal grayscale sonogram of the testicle in a 2-year-old boy with a heterogeneously echoic mass (white arrows) containing foci of shadowing calcifications. Final pathologic examination on resection revealed a mature teratoma.
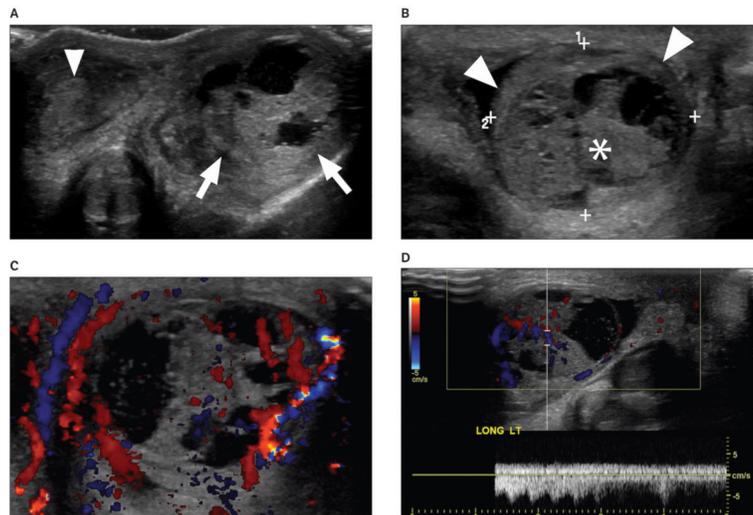
Figure 6.
Juvenile granulosa cell tumor. **A**, Transverse grayscale sonogram of both testicles in a 3-day-old boy presenting with a left testicular mass on the second day of life. The image shows the superior portion of the normal right testicle (white arrowhead) but near complete replacement of the left testicular parenchyma by a $1.6 \times 1.9 \times 1.9$-cm solid and cystic mass (white arrows). **B**, Transverse grayscale sonogram of the left testicle in the same patient showing a thin rim of normal testicular parenchyma (white arrowheads) on one side of the mass (white asterisk), which was also seen on pathologic examination. **C** and **D**, Transverse color Doppler image of both testicles (**C**) and longitudinal color Doppler image of the left testicle (**D**) in the same patient showing the mass to be hypervascular. Laboratory analysis revealed a serum β-hCG level of less than 1 IU/L and a serum AFP level of 17,260.2 μg/L. Radical left orchiectomy was performed on day 6 of life, and the pathologic examination revealed a juvenile granulosa cell tumor.
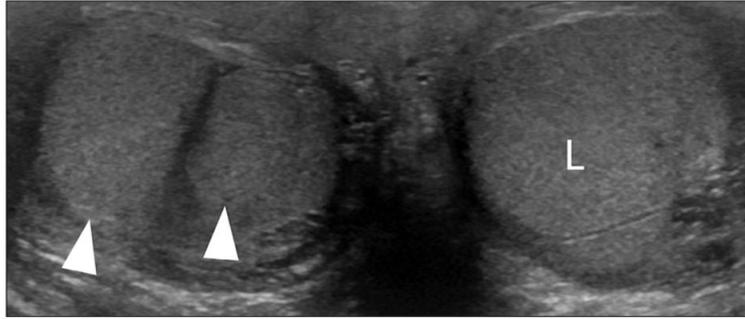
Figure 7.
Supernumerary testicle. Transverse grayscale sonogram of the scrotum in a 13-year-old boy showing 2 testicles in the right scrotal sac (white arrowheads) and a single left testicle (L) in the left scrotal sac.
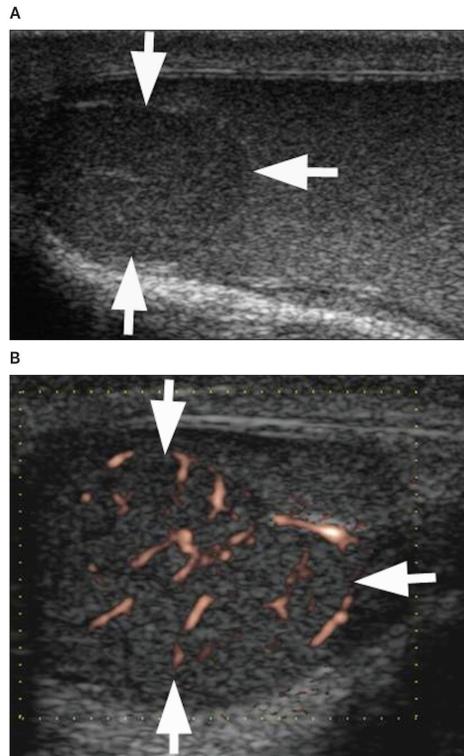
Figure 8.
Splenogonadal fusion. **A**, Longitudinal grayscale sonogram of the testicle in a young adult patient showing a focal mass (white arrows) that is slightly hypoechoic compared to the background parenchyma. **B**, Transverse color Doppler image of the testicle in the same patient showing markedly increased blood flow within the hypo echoic testicular lesion compared to the adjacent parenchyma. Final pathologic examination on resection revealed splenogonadal fusion. Images obtained with permission from Taco Geertsma, MD (Gelderse Vallei Hospital, Ede, the Netherlands).
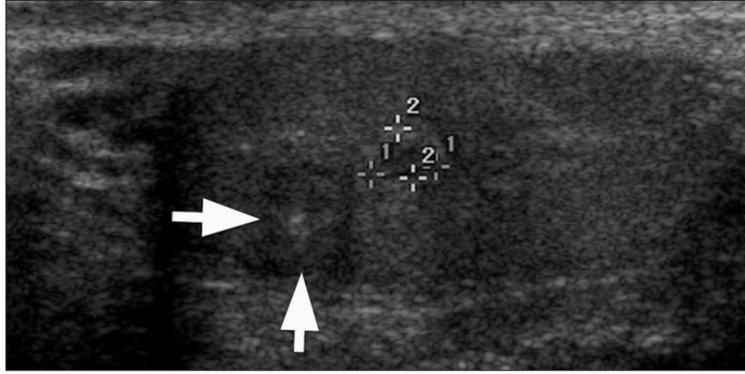
Figure 9.
Adrenal rests. Longitudinal grayscale sonogram in an 18-year-old patient with late-onset congenital adrenal hyperplasia showing a hypoechoic lesion in the testicular parenchyma (white arrows). A smaller hypoechoic parenchymal lesion (between calipers) is also present.
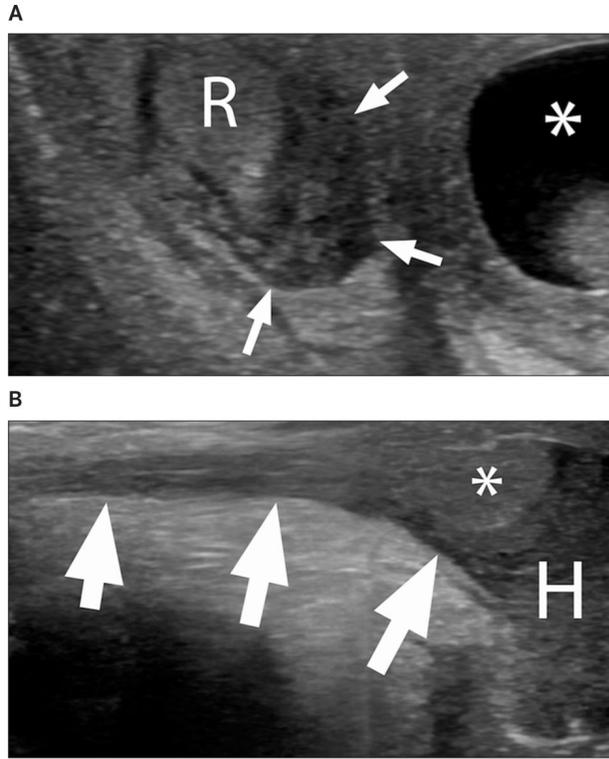
Figure 10.
Scrotal hematoma. **A**, Transverse grayscale sonogram of the right testicle in an 8-day-old, ex-36-week premature boy with complex congenital heart disease, renal anomalies, dysmorphic features, and a liver hematoma presenting with bluish discoloration of the left scrotum. The image shows a large left simple hydrocele (white asterisk) and homogeneously echogenic fluid (white arrows) surrounding the right testicle (R). **B**, Longitudinal grayscale sonogram of the right inguinal canal in the same patient showing a homogeneously echogenic hematoma (H) within the scrotal sac, surrounding the testis (white asterisk). This hematoma extends through a patent processus vaginalis (white arrows).
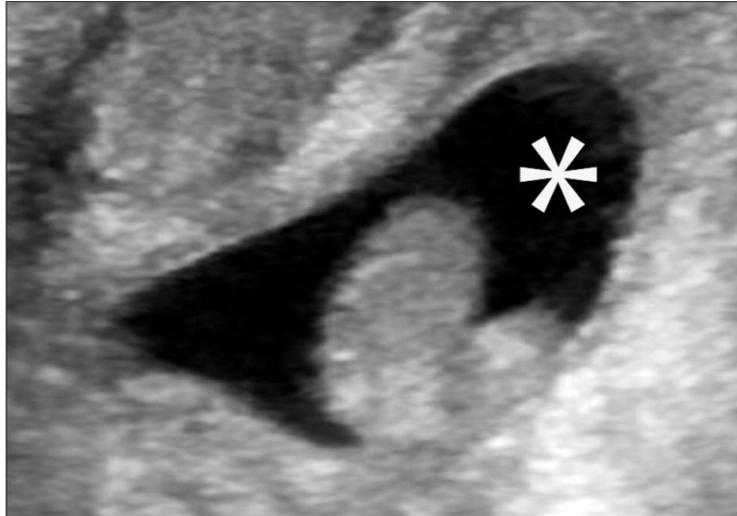
Figure 11.
Simple hydrocele. Grayscale sonogram of the hemiscrotum in a 2-day-old boy showing anechoic fluid (white asterisk) surrounding the testis, compatible with a simple hydrocele.
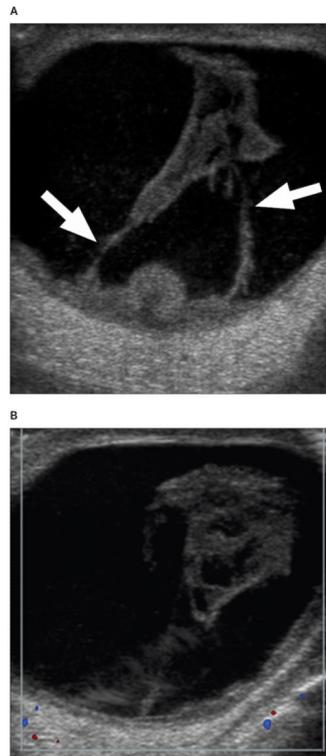
Figure 12.
Complex hydrocele. **A**, Transverse grayscale sonogram of the right scrotal sac in an ex-28-week premature boy (with a corrected gestational age of 34 weeks 6 days at the time of this image) showing a complex hydrocele with layering debris and multiple internal septations (white arrows). **B**, Color Doppler interrogation revealed no internal vascularity within the septations.
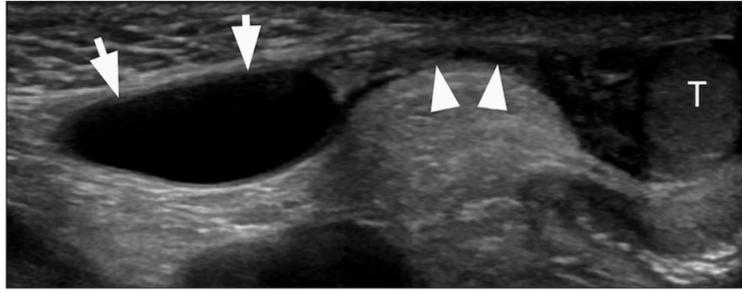
Figure 13.
Encysted spermatic cord hydrocele. Longitudinal grayscale sonogram of a 6-week-old boy showing an anechoic ovoid structure (white arrows) present in the inguinal canal. This structure does not communicate with the peritoneal cavity or the scrotal sac and is separated from the scrotal sac by a normal spermatic cord (white arrowheads). A normal left testicle (T) is present in the scrotal sac.
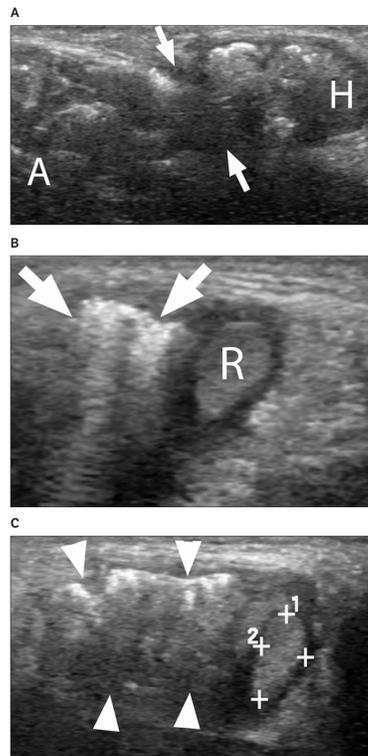
Figure 14.
Inguinal hernia. **A**, Longitudinal grayscale sonogram of the proximal right inguinal canal in a 2-week-old boy with abdominal distention, dysmorphic features, and a nonpalpable right testicle. The image shows a right inguinal hernia (H) that contains bowel extending from the abdominal cavity (A) through the proximal inguinal ring (white arrows) into the inguinal canal. **B**, Transverse grayscale sonogram of the inguinal canal in the same patient showing echogenic air (white arrows) within bowel loops. Real-time sonography revealed bowel peristalsis, and subsequent color Doppler imaging showed preserved blood flow. Note the adjacent undescended right testis (R). **C**, Longitudinal grayscale sonogram of the right inguinal canal in the same patient showing an undescended right testicle (surrounded by calipers) located adjacent to herniated bowel (white arrowheads) in this patient with a chromosome 16p interstitial duplication on microarray analysis.
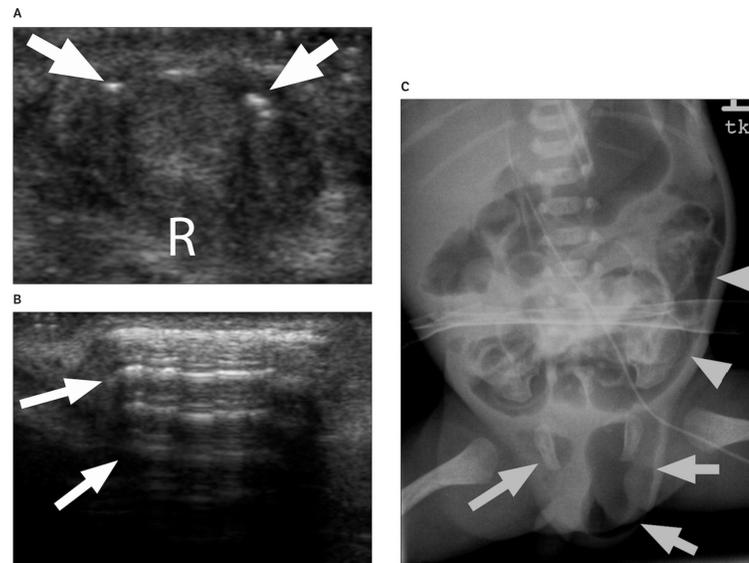
Figure 15.
Intrascrotal air. **A**, Transverse grayscale sonogram of the right hemiscrotum in a 2-week-old, ex-27-week premature boy with necrotizing enterocolitis presenting with a swollen left scrotum. Punctate echogenic foci, consistent with air, are noted in the nondependent portion of the right hemiscrotum adjacent to the right testicle (R). **B**, Longitudinal grayscale sonogram of the left hemiscrotum in the same patient showing nondependent echogenicity within the scrotum with a ring-down artifact (white arrows), compatible with intrascrotal air, which obscured evaluation of the scrotal contents. **C**, Abdominal radiograph in the same patient showing free air within the peritoneal cavity (white arrowheads) and right and left scrotal sacs (long white arrow and short white arrows, respectively).