Classifying Hydroceles of the Pelvis and Groin: An Overview of Etiology, Secondary Complications, Evaluation, and Management

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Key Words
Hydrocele • Scrotal pain • Scrotal swelling • Incontinence • Sexual dysfunction • Hernia • Infection of hydrocele • Infertility • Cystic masses

Abstract
Introduction: A hydrocele is defined as the pathological buildup of serous fluid in the pelvis and groin due to various etiologies such as diseases or trauma. It has distinct clinical manifestations, particularly discomfort and psychosocial distress. Understanding the anatomy, embryology, and physiology associated with hydrocele formation is crucial to understand its onset and progression. Materials and Methods: A MEDLINE\textsuperscript{\textregistered} search was conducted using keywords for the relevant classification of hydrocele and its etiology, complications, sexual barriers, evaluation, and management. Results: Appropriately classifying the hydrocele as primary, secondary communicating, secondary noncommunicating, microbe-induced, inflammatory, iatrogenic, trauma-induced, tumor-induced, canal of Nuck, congenital, and giant is important for identifying the underlying etiology. Often this process is overlooked when the classification or etiology is too rare. A focused evaluation is important for this, so that timely management can be provided. We comprehensively review the classifications, etiology, and secondary complications of hydrocele. Pitfalls of current diagnostic techniques are explored along with recommended methods for accurate diagnosis and current treatment options. Conclusion: Due to the range of classifications and etiologies of hydrocele in the pelvis and groin, a deliberate differential diagnosis is essential to avoiding imminent life-threatening complications as well as providing the appropriate treatment.

Introduction

A hydrocele is marked by a fluid-filled sac typically found in the scrotum, and less commonly in the external genitalia and pelvic regions. It may be a manifestation of certain severe underlying diseases. The fluid collection may result from patent processus vaginalis or an imbalance of secretion and absorption within the tunica vaginalis. A hydrocele can be organized into several classifications that can affect males and females of any ages. Hydrocele is characteristically painless, but can lead to physical and psychological complications. Further complications may be avoided if proper diagnostic and therapeutic techniques are employed. Upon discussing the anatomical, embryological, and physiological background of hydrocele, we comprehensively review its classifications, etiology, pathogenesis, secondary complications, evaluation, and management. Pitfalls of current diag-
Fig. 1. Primary hydrocele. **A** Hernia of hydrocele, **B** multiloculated hydrocele, **C** vaginal hydrocele. Illustrated by Yiji Suh.

Fig. 2. Secondary communicating hydrocele. **A** Communicating hydrocele, **B** funicular hydrocele, **C** bilocular hydrocele (en-bisac), **D** hydrocele of the hernial sac, **E** hydrocele secondary to incarcerated hernia, **F** infantile hydrocele. Illustrated by Yiji Suh.

Fig. 4. Microbe-induced hydrocele. **A**) Parasitic hydrocele, **B**) elephantiasis hydrocele, **C**) filarial dance hydrocele, **D**) pyocele, **E**) syphilitic hydrocele, **F**) tuberculous hydrocele. Illustrated by Yiji Suh.

Fig. 5. Iatrogenic hydrocele. **A** Ventriculoperitoneal shunt resulting in hydrocele following migration of the peritoneal shunt, **B** penile hydrocele post-insertion of penile prosthesis, **C** reactive hydrocele following migration of penile prosthetic pump. Illustrated by Yiji Suh.

Fig. 6. Tumor-induced hydrocele; **T**: tumor. **A** Testicular tumor hydrocele, **B** epidydimal tumor hydrocele, **C** spermatic cord tumor hydrocele, **D** mesothelioma tumors of the tunica vaginalis. Illustrated by Yiji Suh.
nostic techniques are explored along with recommended methods for accurate diagnosis and current treatment options.

**Anatomy, Embryology, and Physiology**

The inguinal region, or groin, is located at the bottom of the anterior abdominal wall. It embodies a tubular passage known as the inguinal canal, which spans from the pelvis to the groin. The inguinal canal has two openings: the deep inguinal ring and superficial inguinal ring. Though the structure of the canal is similar among males and females, its function varies with gender. For males, the canal allows the spermatic cord to pass between the testes and abdomen. In females, the canal provides a path for the round ligament of the uterus from the uterus to the labium majus.

During embryonic development, the inguinal canal also embodies the processus vaginalis, a structure that develops from the peritoneum during gestational week 12. In males, it extends through the inguinal canal into the scrotum, allowing the testes to descend into the scrotal sac. Following completion of testicular descent, the processus vaginalis undergoes programmed cell death to obliterate the path between the peritoneum and scrotum. After closure, the lower portion of the processus vaginalis becomes the tunica vaginalis testis. Failure to close results in a patent processus vaginalis, which leads to complications such as communicating hydrocele and inguinal hernia. Failure to close the processus vaginalis in females results in formation of a patent pouch of the peritoneum called the canal of Nuck. The canal of Nuck is also associated with complications of inguinal hernia and communicating hydrocele [1].

Hydrocele results from the collection of fluid in the bilayered tunica vaginalis. This fluid typically accumulates in infants due to the patent processus vaginalis, allowing peritoneal fluid to flow through the processus vaginalis into the scrotum and surround the testicle [2]. If the excess fluid cannot drain, accumulation results. The potential origins of fluid in the scrotum are outlined in table 1.

**Classification**

Hydroceles can be classified into primary (fig. 1), secondary communicating (fig. 2), secondary noncommunicating (fig. 3), microbe-induced (fig. 4), inflammatory, iatrogenic (fig. 5), trauma-induced, tumor-induced (fig. 6), canal of Nuck (fig. 7), congenital, and giant (fig. 8). A primary hydrocele is an idiopathic hydrocele with no known etiology. When diagnosed, a primary hydrocele is
clinically tense and not palpable under physical examination. Secondary hydrocele includes communicating and noncommunicating hydrocele. These types of hydrocele underlying the testicle can be partially palpated under physical examination. Communicating hydrocele occurs when a path exists between the peritoneal cavity and scrotum or the peritoneal cavity and inguinalabial region. This path results from the patent processus vaginalis, which may be partial or completely open [3, 4], and not communicate with the abdomen while there is a small processus vaginalis or an entirely obliterated one. It is typically located in the tunic vaginalis and does not change in size [5, 6]. Hydrocele may develop secondary to: dislocated testicle, testicular infarction, microlithiasis of testicle, lithiasis of tunica vaginalis, sarcoidosis of the testicle, retained foreign body (e.g. bullet or glass), as well as sharp object injury (e.g. icicle or toothpick).

Giant hydroceles are classified when the hydrocele is larger than the patient’s head or larger than 1,000 ml of content. The penis may become hidden. Although rare, there are few reported cases in the medical literature [7].

Hydrocele of the canal of Nuck, also known as female hydrocele or cyst of the canal of nuck, affects infant females and results in painless or possibly painful inguinal swelling. It is an uncommon disease caused by the failure of the processus vaginalis to close during embryological development which can lead to inguinal hernia and hydrocele [8]. The enlargement of the cyst is likely due to an imbalance of secretion and absorption of fluid of the secretory membranes that envelope the processus vaginalis. Possible causes of the imbalance in lymphatic drainage are trauma and infection; it is most frequently idiopathic [9]. Hydrocele of the undescended testicle is a congenital cause in males.

Parasitic hydrocele is associated with hydatid cysts and filariasis. Hydatid disease, also referred to as echinococcosis, is a major problem in Mediterranean countries [10] and can sometimes present as hydrocele [11, 12]. Filarial hydrocele is a type of lymphatic filariasis prevalent in patients of developing countries [13]. It is caused by a mosquito-born parasite called *Wuchereria bancrofti* and affects 100 million people worldwide.
larial hydrocele is one of the most common complications of lymphatic filariasis [14] and can be extremely dangerous due to potential rupture of lymph fluid from dilated lymphatic vessels, which may complicate testicular function [15]. The fluid of hydrocele is prone to infection. In endemic parts of India, West and East Africa, and Saudi Arabia, microfilaria can infect hydrocele fluid leading to further complications [16]. Studies conducted in Nigeria and Nepal [13, 14] report the need for elimination of lymphatic filariasis. Advances in treatment options, control, diagnosis, and clinical understanding have led to anti-filarial campaigns [17, 18].

Both hydrocele and hernias are common throughout infancy and childhood; inguinal hernia repair is one of the most common surgeries performed during these times [19]. Hernias and hydroceles typically occur together due to similar pathology. They both result from an abnormality with the processus vaginalis [20]. Hydrocele of the femoral hernia can be classified as communicating or noncommunicating [22]. It may be difficult to prediagnose hydrocele of the femoral hernia without exploration due to an irreducible or incarcerated femoral hernia obstructing the hydrocele [23].

Table 1. Collection of biological fluids within the scrotum presenting as hydrocele

<table>
<thead>
<tr>
<th>Fluid or condition</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcutaneous emphysema</td>
<td>iatrogenic, gas-producing infection, scrotal trauma, pneumothorax [34]</td>
</tr>
<tr>
<td>Hematocele</td>
<td>angiookeratoma of the scrotum, urinary tract tumors, varicoceles, hernias, intra-abdominal mass [35], hemoperitoneum from splanchnic hematoma [36], patent processus vaginalis [37]</td>
</tr>
<tr>
<td>Bile</td>
<td>laparoscopic cholecystectomy [38]</td>
</tr>
<tr>
<td>Cerebrospinal fluid</td>
<td>ventriculoperitoneal shunt [31]</td>
</tr>
<tr>
<td>Peritoneal fluid</td>
<td>abdominoscrotal hydrocele [39]</td>
</tr>
<tr>
<td>Pyocele</td>
<td>Fournier’s gangrene secondary to hydrocele [40, 41]</td>
</tr>
<tr>
<td>Lymphocele</td>
<td>filariasis [42], laparoscopic treatment [43]</td>
</tr>
<tr>
<td>Scrotal urinoma</td>
<td>renal transplant [44], ureteral calculus drainage from a scrotal incision [45]</td>
</tr>
<tr>
<td>Pneumoscrotum</td>
<td>air accumulation from the lung, retroperitoneal sources, infection with gas producing bacteria, surgical manipulations [46]</td>
</tr>
<tr>
<td>Meconium</td>
<td>utero perforation of the bowel, spillage into peritoneal cavity [47]</td>
</tr>
<tr>
<td>Tumor-induced</td>
<td>Wilms tumor, tumor invading tunica albuginea and vaginalis testis [48, 49]</td>
</tr>
<tr>
<td>Giant hydrocele</td>
<td>hematocyte, calculus formation [7]</td>
</tr>
</tbody>
</table>

Iatrogenic disruption of the lymphatic system can cause hydrocele. Post-varicocelectomy hydrocele occurs through disruption of lymphatics around the spermatic cord. This postoperative complication has an occurrence rate of 3–33% [24]. Hydroceles have been reported as postoperative complications for inguinal herniotomies (IH), ventriculoperitoneal shunts, and renal transplants [25, 26]. The hydrocele resulting from an IH typically resolves without further treatment [27]. Prevention of a postoperative hydrocele from IH is carried out by careful incisions during surgery. For example, overzealous excisions of fat along the spermatic cord and careful ligatures of lymphatics are some methods for prevention [28]. Ventriculoperitoneal shunts for treatment of hydrocephalus may migrate into the right hemiscrotum through the processus vaginalis, leaking cerebrospinal fluid [29–31]. Hydrocele following renal transplant presents dangerous complications. The hydrocele may become infected with bacteria post-transplantation. For example, a renal transplant patient experienced hydrocele with cutaneous group A β-hemolytic streptococcal infection [32]. Another renal transplant patient presented with seminoma and hydrocele [33]. Other iatrogenic etiologies include: hydrocele post-radiotherapy of spermatic cord or groin, hydrocele post-varicocelectomy or herniorrhaphy, hydrocele of ectopic testicle post-transposition, hydrocele post-testicular biopsy, as well as hydrocele of testicular prosthesis.
Etiology

Among the many causes of hydrocele, the most common tends to be the disruption of the lymphatic system. Surgeries, such as laparoscopic varicocelectomy, can either partially or completely disrupt testicular lymphatic drainage, which leads to the postoperative complication of hydrocele [50]. The imbalance of drainage and input into the lymphatic tissue surrounding the scrotum is another cause of hydrocele [9, 51]. The potential causes of painful hydrocele are listed in table 2.

When hydrocele is the noncommunicating type, aquaporin channels may be responsible. Hattori et al. [52] investigated the expression of aquaporin channels in relation to noncommunicating hydrocele. Tunica vaginalis of patients with hydrocele were studied and then compared to a non-hydrocele infected male control. Western blot analysis was used to find aquaporin channels 1 and 3. Aquaporin channels function to regulate water flow across the plasma membrane, and an abnormality with these channels could be linked to hydrocele formation. The study concluded by noting an overexpression of aquaporin channel one within the tunica vaginalis in patients with a hydrocele. The hydrocele fluid may manifest from increased fluid output from capillaries that contain the overexpressing aquaporin channel 1, leading to lymphatic drainage that is less than the output. This pioneering study leads to speculation and should encourage further exploration as to the role of aquaporin channels and their connection to hydrocele.

Giant hydroceles are caused mostly due to phobia and neglect from the patient. They are most likely to be encountered in poor third world countries where the patient does not have the means or resources to treat the hydrocele. When a giant hydrocele is not treated, it has serious implications on the patient’s quality of life [7].

A hydrocele can also occur after renal transplantation. This arises most probable because of lymphatics that have been disturbed. Penn et al. [53] discusses a study consisting of a series of renal transplantations and testicular complications. Hydrocele was the most common complication due to a disruption of lymphatic channels along the iliac vessel. The lymphatic disruption caused the hydrocele because it negatively affected the absorption of the lymphatics despite regular secretion of the fluid.

A rheumatoid hydrocele is a rare manifestation of hydrocele. Ijaz [54] reports a 53-year-old male who underwent hydrocele repair surgery with brown deposits on the inside of the tunica vaginalis. The deposits were biopsied and identified as vascular fibrous tissue with foci of necrobiosis, surrounded by palisaded macrophages. This is a characteristic of a rheumatoid-like tissue response. This immune response towards the tunica vaginalis could be the explanation as to why this patient developed hydrocele.

Secondary Complications

Masses that abnormally present within the scrotum have the potential to affect negatively the surroundings. The pressure within the testis can decrease the efficiency of spermatogenesis. According to 120 biopsies conducted by Dandapat et al. [62], patients with and without hydrocele, those with hydrocele exhibited atrophy in 8% and flattening of the testis in 22% of cases studied. Ten percent of affected patients had a partial arrest of spermatogenesis while 8% had a total arrest. Other histological findings include thickening of the basement membrane, tunica albuginea, and tunica vaginalis. The arrests of spermatogenesis likely due to increased pressure on the blood supply on the testis from edema [62, 63].

Failure to perform spermatogenesis may also result from a rise in intrascrotal temperature [62]. Water, which has a very high specific heat compared to other liquids, is the major component of hydrocele. Due to resistance to the thermoregulatory mechanism, water can hold onto heat very well, leaving the area incapable of heat dissipation. High heat from water being trapped within the scrotum leaves the scrotum at a temperature too high for optimum spermatogenesis [64, 65]. Semen quality has been shown to decrease by 40% for every 1°C the scrotum increases [66]. Hydrocele has a direct link to male infertility.

Benign and malignant tumors of the tunica vaginalis may be overshadowed by hydrocele. Zaslau et al. [67] discuss a case of a malignant tumor of the tunica vaginalis that was disguised as a hydrocele. The patient initially presented with a large scrotal mass that was not tender and transilluminated. He complained of discomfort and a heavy feeling. The patient underwent a hydrocelectomy due to an initial diagnosis of noncommunicating hydrocele. With examination of the hydrocele sac, carcinoma was found arising from the tunica vaginalis. This case presents the possibility for hydrocele to mask underlying problems and underlying problems, including tumors of tunica vaginalis [68].
Though hydrocele typically presents as a painless mass, it can lead to psychological complications responsible for sexual dysfunction and infertility. Gyapong et al. [69] examined the burden of hydrocele within a community in Ghana. The authors found that unmarried men with hydrocele could not find a spouse due to negative associations of hydrocele. Sexual dysfunction was prevalent among married men with hydrocele, exhibiting a decrease in sexual desire and difficulty to have to become tumescent. Infertility is another factor contributing to the psychological burden of hydrocele patients [7]. Men fear hydrocele formation due to sexual and social disadvantages that can arise from a hydrocele present [69, 70]. The sexual barriers of hydrocele include pain and dyspareunia, infertility, ejaculatory disorder, pseudo shortening of penis, erectile dysfunction, buried penis, social stigma, embarrassment and body dysmorphic disorder [72]. Hydrocele may produce infertility due to compartment syndrome, compression, and increased temperature of hydrocele, as water is resistant to transmission of heat [71].

Traumatic, inflammatory and painful complications of hydrocele include rupture, pain, pyocele, infection, hematomecele, and intertrigo of the scrotal wall, and sexual dysfunction secondary to buried penis. Hydrocele rupture can occur spontaneously or due to trauma or pressure directed on the hydrocele sac [73, 74]. Pain associated with hydrocele may result from acute attacks of scrotum, penis, or urethra and may present as tenderness, dull aches, and pulling sensations [69, 75]. Infections of hydrocele can be morbid if not treated immediately. Sarwar et al. [40] reported a case of an infected hydrocele leading to Fournier’s gangrene, a type of necrotizing fasciitis. Days after treatment of this painless hydrocele, spreading cellulitis and necrosis were observed. Hydrocele aspiration leaves patients with a predisposition towards Fournier’s gangrene. Bacteria exposure, such as that resulting from a ruptured appendix, may lead to infection of an already present hydrocele [76, 77]. Hematomecele may be caused by aspiration, trauma, or rupture. A rupture of an abdominoscrotal hydrocele causing hematomecele requires immediate surgical treatment [78].

Deposition of organic matter within the bilayered tunica vaginalis can result from hydrocele. Scrotal calculi and hydrocele stones can be found during hydrocele repair surgery. Infrared spectroscopy is helpful in determining the composition of organic masses. Stones can form regardless of hydrocele size and originate from fibrous deposits in the tunica vaginalis after trauma or inflammation. These masses are rarely reported but remain common in clinical practice [79]. Long-term hydrocele may be a predisposing factor for complications such as focal thickening of tunica vaginalis and lobulated masses mimicking epididymal tumors [80]. Infection of hydrocele fluid may lead to a multiloculated hydrocele, secondary to epididymo-orchitis.

Appendicitis can cause an infected hydrocele if the hydrocele can communicate with the abdomen cavity and the hydrocele sac. In a case report by Lantsberg et al. [81], a 20-year-old patient had a laparoscopic appendectomy and then acquired an infected hydrocele as a result. The authors recommended avoiding laparoscopic surgery in patients with a hydrocele. Hydrocele can also be the cause of appendicitis. An abdominoscrotal hydrocele compressed on the appendix, causing compression and subsequently, appendicitis. Appendicitis can be caused and complicated by variations of hydrocele [82].

Hydrocele can cause stress to other tissues around the body, especially sensitive ones like the testis. The pressure in a hydrocele can become so great that it surpasses the blood pressure of the blood vessels within the scrotum and results in ischemia. From this, a study by Wright et al. [83] found that tension from a hydrocele caused testicular ischemia. This situation is comparable to testicular compartment syndrome and upon diagnosis, any pain accompanied with hydrocele should be ruled out when coming to a diagnosis. Other types of stress a hydrocele can cause include a social perspective. A giant hydrocele may completely change how the individual lives their life. Giant hydroceles affect the patient’s work capacity, sexual function, and overall quality of life. The weight alone is discomforting and pulls at the skin and impairs the patient’s mobility. Giant hydrocele has also created hardships such as teasing, sexual dysfunction, divorce due to unsuitability for marriage, as well as difficulty in wearing proper attire. Foul odor from intertrigo may cause embarrassment. Physical complications include pressure necrosis along with wound infection, hematomecele, calcification of the sac, infertility, and calculus formation [7].

Insertion of the Three-Piece Penile Prosthesis may pose a significant problem in patients with hydrocele. The pump in the scrotum would become difficult to activate and deactivate. This is a preoperative problem in patients with hydrocele.

As mentioned above, the complications include sexual dysfunction, infertility, rupture, pain, pyocele, infection, Fournier’s gangrene, hematomecele, intertrigo, scrotal calculi, hydrocele stones, appendicitis, and testicular ischemia.
Effusion of fluid into extracellular space

Table 4. Cystic inguinal and scrotal masses

<table>
<thead>
<tr>
<th>Testicular masses</th>
<th>Non-Testicular masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torsion of the testicular appendage</td>
<td>epididymitis</td>
</tr>
<tr>
<td>Testicular torsion</td>
<td>bladder Hernia</td>
</tr>
<tr>
<td>Spermatocele</td>
<td>bladder diverticulum</td>
</tr>
<tr>
<td>Hydrocele</td>
<td>urethral diverticulum</td>
</tr>
<tr>
<td>Varicocele</td>
<td>syringocoe</td>
</tr>
<tr>
<td>Testicular cancer</td>
<td>testicular cysts</td>
</tr>
<tr>
<td>Epidermoid cyst [109]</td>
<td>epidymal cysts</td>
</tr>
<tr>
<td>Simple cyst [109]</td>
<td>cystic tumors of testicle</td>
</tr>
<tr>
<td>Granulosa cell tumor [109]</td>
<td>lymphangioma</td>
</tr>
<tr>
<td>Dermoid cyst [109]</td>
<td>massive inguinal hernia</td>
</tr>
<tr>
<td>Prepubertal teratoma [109]</td>
<td>congenital diaphanous distended loop of bowel (mistaken on transillumination)</td>
</tr>
<tr>
<td>Massive lipoma of the testicle</td>
<td>fat necrosis of the scrotal wall</td>
</tr>
<tr>
<td>Tunica albuginea cyst</td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation**

**Clinical Evaluation**

Transillumination is one of the most common techniques used to diagnose hydrocele. It is widely believed that if light shines through the scrotum during transillumination, the mass is cystic, and if the light is blocked, the mass is solid [84]. The ability of light to pass through an object depends on the object through which the light passes. If an object is less permeable, then less light will shine through it. Factors that play a role in light permeability include density, thickness, and size. Thickening of the tunica vaginalis prevents accurate hydrocele identification via transillumination. Thick-walled tissue creates a situation where light cannot pass through and leaves transillumination ineffective [80]. Other barriers to transillumination that prevent light from passing through the scrotum include hydrocele calculi, hydroceles stones, testicular calcifications, bowel obstruction, and hernia [79, 85]. Tumors accompanied with hydrocele can obstruct the transillumination [86]. Other options should be considered when diagnosing hydrocele; scrotal ultrasoundography with duplex Doppler is an appropriate test for hydroceles.

**Imaging Studies**

Duplex Doppler sonographic assessment is the recommended diagnostic tool for identifying hydrocele. This method identifies hydrocele in patients that may have intrascrotal calcifications or non-palpable hydrocele [87]. Ultrasonography helps eliminate misdiagnosis, especially when hydrocele is accompanied with tumors [88]. Ultrasound may be used to prenatally diagnose infants for inguinal or scrotal hernia as well as contratralateral hydrocele. Using a multifrequency 3D transducer, a sonographic hydrocele is presented as a crescent shape. Finding and identifying scrotal masses in neonatal patients is important as they can be treated more readily [89]. Patients should be placed in both supine and upright positions during examination as the hydrocele may reduce into the abdomen depending on the position of the patient [90].
Color Doppler ultrasonography is a great variation of duplex Doppler diagnosis. Color Doppler ultrasonography can help differentiate scrotal masses and diseases. Color Doppler ultrasonography can also help identify anatomy and perfusion in real time for the scrotal area. This method can identify intratesticular versus extratesticular abnormalities. Sensitivity to scrotal disease is reported to be 98% with 68% specificity. The main advantage of color Doppler ultrasonography over grey scale is that grey scale lacks specificity for parenchymal changes, and benign and malignant lesions cannot be distinguished from one another. Ultrasonography is the first and most often the only option needed to make a diagnosis. The resistive index is another aspect that is important to consider when undergoing diagnostic testing. The resistive index for a normal testicle is low, while hydrocele presents with a high resistive index spectral flow pattern [91]. When color Doppler ultrasonography presents with inconclusive data, magnetic resonance imaging (MRI) should be the next viable diagnostic measure [92]. Imaging should be performed with upright and supine position from internal ring to the bottom of the scrotum to determine the pathophysiology.

Computed tomography (CT) scan with and without contrast is an appropriate imaging study in patients with complex undiagnosed or difficult to diagnose hydrocele on ultrasound. Hydrocele or hydrocele associated with inguinal, femoral hernias, appendicitis, sudden-onset, painful, febrile or other iatrogenic hydrocele, or other etiology should utilize scrotal ultrasound and duplex Doppler, followed by CT scan [93].

MRI of the scrotum or inguinal canal region provides additional information and increases diagnostic accuracy. Examples of additional information that has been

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**Fig. 9.** Hydrocele imitations. **A** Scrotal edema, **B** bladder diverticulum, **C** congenital diaphanous distended loop of bowel (mistaken on transillumination), **D** fat necrosis of the scrotal wall, **E** mesothelial cysts. Illustrated by Yiji Suh.
brought up through MRI include intratesticular hematoma, hematoceles, and extension of the inguinal canal. An MRI can check for possible misdiagnosis made through ultrasonography. In one case, an albuginea of an intact testis was misdiagnosed as a line of fracture [94]. It is also useful to have an MRI done when the case at hand presents with difficulty. Such difficulties include scrotal wall thickening, calcinosis, hydrocele stones or tumors [95–98]. These occurrences can provide difficulty in the visualization of the scrotum and its contents so therefore an MRI is essential. An MRI examination prevents unnecessary surgical exploration, which will ultimately reduce overall costs and length of hospitalization for the patient [94].

Differential Diagnosis

Different pathologies can exhibit symptoms mimicking those of hydrocele (tables 3–5). The differential diagnosis also includes: lipomatosis of the lower anterior abdominal wall causing hidden penis, saxophone penis [99], and webbed penis [100]. Examples of conditions imitating hydrocele are depicted in figure 9.

Management

There are two categories of surgical treatment, invasive and noninvasive. Each offers advantages over the other, but whether or not a single method is preferred is yet to be established [110].

Noninvasive Options

Detailed examination and ultrasound with duplex Doppler in upright and supine position must be performed before aspiration and sclerosing agents are used to treat hydrocele. Two of the more frequently used noninvasive treatment options are aspiration and sclerotherapy. These methods are best used in conjunction with each other. When hydrocele is treated with aspiration alone, it typically reappears [110]. According to one study, aspiration and sclerotherapy with doxycycline has an 84% success rate. There are other types of sclerosing agents besides doxycycline that may be used with sclerotherapy; they are presented in table 6. Such agents may be considered just as successful as hydrocelectomy. Size of the hydrocele can be a useful measurement for predicting whether treatment will benefit a patient. A hydrocele size of more than 750 ml is a cutoff point for some treatments. Aspiration and sclerotherapy are less expensive than hydrocelectomy. One estimate by Rush University Medical Center puts the cost for aspiration and sclerotherapy at $459.13 and hydrocelectomy at $12,322.34 [111]. Complications that may arise from aspiration and sclerotherapy treatment include recurrence of the hydrocele and partial gangrene [112]. Some predispositions that are considered contraindications for sclerotherapy are discussed in table 7.
In a rare situation, a diver suffered from decompression illness and manifested hydrocele. Bubbles in body fluid, coming from dissolved inert gas were present, which resulted in tissue swelling. An obstruction of lymphatic drainage from nitrogen bubbles was the speculated cause of hydrocele formation. The patient was treated with a hyperbaric oxygen chamber and the hydrocele resolved itself spontaneously, prompting this method of treatment for hydrocele patients with a history of recent diving [123].

Surgical Procedures
Hydrocelectomy is one of the main surgical treatments for hydrocele. This procedure is highly recommended when the hydrocele is large and persistent [124]. Hydrocelectomy is more invasive compared to its nonsurgical counterpart, but in some cases has a higher success rate. The main drawback of hydrocelectomy is its postoperative complications. Postoperative complications include scrotal edema, hematoma, chronic pain, decreased fertility, persistent swelling, Fournier’s gangrene, and infection [125–127]. Minimal access hydrocelectomy is a suggested alternative because it is less invasive and involves a smaller incision. A new minimal access hydrocelectomy is described by Saber that minimizes traumatic insult to the patient without sacrificing safety and efficacy. The operative time is quick (12–18 minutes) and recovery time is shortened in comparison with a traditional hydrocelectomy [126]. The available surgical options are listed with their effectiveness in table 8.

Alternative Treatment
Infants who present with a hydrocele should undergo a more conservative approach to their hydrocele repair if little or no complications are present. Koski et al. conducted a study with infants being treated for communicating hydroceles. The authors proposed taking a more conservative approach for treating these infants. In the study, by simply avoiding surgery in half of the patients below the age of 18 months, the authors concluded it was the safest and most effective method for treating hydroceles in that age range [130].

Conclusion
Numerous etiologies are responsible for hydroceles that can be classified as primary, secondary communicating, secondary noncommunicating, microbe-induced, inflammatory, iatrogenic, trauma-induced, tumor-induced, canal of Nuck, congenital, and giant. Hydrocele should be taken seriously and monitored closely whether it is present in infants or older patients, especially when rare secondary complications are a threat to the patient’s life or quality of life. Diagnosis of hydrocele should shift away from transillumination and more towards radiologic imaging in both supine and upright positions. All treatment options should be considered before eliminating methods on a case-by-case basis.

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References

canal of Nuck for female indirect inguinal hernia. J Am Assoc Gynecol Laparosc 2001;
8:143–146.

2 Valentino M, Bertolotto M, Ruggirello M, Pavlica P, Barozzi L, Rossi C: Cystic lesions and scrotal fluid
collecations in adults: Ultra 
sound findings. J Ultrasound 2011;14:208–
215.

3 Barthold JS, Redman JF: Association of epididymal anomalies with patent processus

4 Rahman N, Lahkoo K: Patent processus genu-
iosis: a window to the abdomen. Afr J Paedi-

5 Christensen T, Cartwright PC, Devries C, Snow BW: New onset of hydroceles in boys
over 1 year of age. Int J Urol 2006;13:1425–
1427.

6 Wilson JM, Aaronson DS, Schrader R, Baskin LS: Hydrocele in the pediatric pa-


8 Akkoyun I, Kucukosmanoglu I, Yalinkilinc E: Cyst of the canal of nuck in pediatric pa-


10 Bouchikhi AA, Lamrani YA, Tazi MF, Mel-

11 Haouas N, Sahraoui W, Youssef A, Thabet I, Ben Sorba N, Jaidane M, Mosbah AT: Hy-

12 Zirkillaev A: Hydatid echinoccosis of paravescular cellular tissue, simulating hydro-


14 Christiana O, Olajumoke M, Oyetunde S: Lymphatic filariasis and associated morbid-


18 Ottesen EA, Duke BO, Karam M, Behbehani K: Strategies and tools for the control/elimina-

19 Kapur P, Cuty MG, Glick PL: Pediatric her-

20 Iabor DO, Ogunyin O O, Ogunjina DL: Pregnancy, parturition, parity and position in the family. Any influence on the develop-

267.


25 Ein SH, Nasr A, Wales P, Gersite T: The very large recurrent postoperative scrotal hydro-
241.


27 Lao OB, Fitzgibbons RJ Jr, Cusick RA: Pediatric inguinal hernias, hydroceles, and unde-

28 Obney N: Hydroceles of the testicle com-


30 Lao OB, Fitzgibbons RJ Jr, Cusick RA: Pediatric inguinal hernias, hydroceles, and unde-

31 Obney N: Hydroceles of the testicle com-


34 Kizer JD, Russell KD, Schnaufer L, Canning DA: Mucous hydrocele in a female new-


romà Ortue A, Acha Pérez M, Albusi Tristán A, Blasco Villalonga M: Cyto
Hydroceles of the Pelvis and Groin

107. Hartshorne MF, Tzamaloukas AH: Scro-
chitis: a neglected cause of male infertility?

108. Sabar R, Safadi W: Relieving the burden: pa-


111. Francis HJ, Levine LA: Aspiration and sclero-

112. Dahl BH: Partial gangrene of the scrotum and penis. A complication of sclerotherapy of testicular hydrocele. Tidsskr Nor Laege-
foren 1993;113:1232.


119. Rencken RK, Bornman MS, Reif S: Multi-


122. Worthington-Kirsch RL: Injection sclero-

123. Dellis AE, Skolarikos A, Vavasis P, Spyrou-

124. Cimador M, Castagnetti M, De Grazia E: Management of hydrocele in adolescent pa-


126. Saber A: New minimally access hydro-


130. Koski ME, Makari JH, Adams MC, Thomas JC, Clark PE, Pope JC 4th, Brock JW 3rd: Infant communicating hydroceles–do they need immediate repair or might some clin-