Critical Manifestations of Pneumosrotum

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Key Words

Pneumosrotum • Scrotum • Fournier's gangrene • Emphysematous-epididymorchitis

Abstract

Introduction: Pneumosrotum is a critical, physical finding that may indicate significant morbidity and mortality. Accumulation of gas in the scrotum can be primary or secondary. **Objective:** This paper discusses rapid diagnosis and treatment options. **Material and Methods:** PubMed searches for pneumosrotum, etiology, diagnosis, and treatment. Results: We review the historical perspective, classification, etiology, diagnosis, and treatment options of pneumosrotum, as well as the presentation of pneumosrotum in neonates/infants. **Conclusion:** It is crucial to diagnose the etiology pneumosrotum and designing a treatment option based off that.

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benign, it is essential to detect and treat the underlying cause [3, 4]. Furthermore the underlying cause of pneumosrotum may be a life threatening disease [2].

Historical Perspective

The first case of pneumosrotum was reported in 1912 by Keyes. This first report involved 2 cases of pneumosrotum that occurred following nephrostomy [5]. Between 1972 and 2013, 59 cases of pneumosrotum were described in the literature [2]. As first reported by Keyes, pneumosrotum also describes scrotal emphysema and scrotal pneumatocele. Scrotal emphysema is described as palpable and presenting with such clinical signs as swelling of the scrotum and palpable crepitus. Pneumatocele is described as not palpable due to the fact that the air is in the tunica vaginalis of the testicle [1, 2].

Classification of Pneumosrotum

The anatomical pathway of air spread that can result in pneumosrotum involves several possible mechanisms. First is from direct air or gas introduction to the scrotum. Gas forming organisms may travel through blood or the lymphatic pathway [6]. The second mechanism is through the thoracic pathway, where air inside the lungs travels along the layers of the Scarpa's and Camper's fascia. The two fascias fuse and form the Colles' fascia located at the base of the penis and Dartos fascia located in the testes. The third pathway is by air from the intra-abdominal region traveling through the abdominal wall by diffusion or through the peritoneal cavity. The intra-ab-

Introduction

Pneumosrotum is a rare condition that manifests with swollen scrotal sac. The swelling results from accumulation of air or gas in the scrotum [1]. Two specific conditions included under the term pneumosrotum are scrotal emphysema with palpable crepitus and scrotal pneumatocele [2]. The causes of pneumosrotum are varied from infections to the spread of gas/air from distant organs or spaces. Although the condition itself is uncommon and

Table 1. Etiology of primary pneumoscrotum

No.	Etiology
1	Scrotal and testicular abscess [3]
2	Clostridia [10]
3	Autoerotic air injection [11]
4	Self-inflicted injury [12]
5	Necrotizing fasciitis [13]
6	Fournier gangrene [14]
7	Scrotal gangrene [15]
8	Gas gangrene [16]
9	Scrotal inflation [17]
10	Emphysematous epididymitis [18] Empididymo-orchitis [19] Infarction [20]

dominal air can then travel along the fascial planes and amass in the scrotum [7]. Occasionally, air may travel via patent processus vaginalis [8].

Primary pneumoscrotum derives from the scrotal wall or scrotal contents. On the other hand, secondary pneumoscrotum is caused by gas or air produced elsewhere and clinically present in the scrotum. Secondary often results from iatrogenic causes. Direct scrotal injury or trauma can result in pneumoscrotum as well [2, 3, 9]. However, documented cases have often revealed scrotal air accumulation caused by diagnostic, therapeutic methods, or disease states, which present in the scrotum as pneumoscrotum. The following tables summarize the various etiologies of pneumoscrotum (Table 1, Table 2).

Etiology

The accumulation of air or gas in the scrotum occurs by different mechanisms. Gas-producing organisms such as clostridia or disease states such as Fournier's gangrene or emphysematous epididymorchits result in local gas production and accumulation [2, 10]. Direct scrotal trauma can also lead to direct air introduction [2, 3, 9]. A second mechanism is triggered by air/gas spread from the thoracic cavity, specifically in the case of pneumomediastinum and pneumothorax where the air dissects from the lungs to the scrotum. How these thoracic issues occur can vary and include blunt trauma to the chest, jet or long-term ventilation, cardiopulmonary resuscitation and chest drainage. Another mechanism is from the peritoneal or retroperitoneal space in which air is able to diffuse from the abdominal wall to the scrotum. Anatomical pathway of spread includes patent processus vaginalis when air/gas dissects into the scrotum from the abdom-

Table 2. Etiology of secondary pneumoscrotum

Classification	Etiology
Thoracic	
1	pneumomediastinum [21]
2	pneumothorax [2] (traumatic [22] or spontaneous [23])
3	blunt trauma [2, 3]
Retroperitoneal	
1	retroperitoneum trauma [24]
2	emphysematous infections [25]
Intra-abdominal/ intraperitoneal	
1	pneumoperitoneum [26]
2	visceral perforation [8, 27–29]
3	abdominal trauma [2]
4	jet ventilation [30]
Perforation	
1	duodenal [31]
2	retroduodenal [32]
3	jejunal [8]
4	sigmoid diverticulum [13]
5	colon [33]
6	Meckel's diverticulum [34]
7	gastric [29]
8	peptic ulcer [35]
9	inguino-scrotal hernia [36]
10	esophageal [37]
Other	
1	emphysematous pyelonephritis [38]
2	pneumatosis intestinalis [39]
3	intestinal atresia [36]
4	renal colic [40]
Iatrogenic	
1	liver or kidney biopsy [41]
2	endoscopic sphincterotomy [42]
3	endoscopic papillotomy [32]
4	endoscopic resection [43]
5	colonoscopy [44] (therapeutic [28], polypectomy [10])
6	laparoscopy [45]
7	arthroscopy [46]
8	peritonoscopy [47]
9	colon [48]
10	renal surgery [49]
11	pneumothorax drainage [50]
12	drainage of hydrocele
13	testicular biopsy
14	pulmonary resection for carcinoma [51]
15	endotracheal catheter [52]
16	endoscopic retrograde cholangiopancreatography [53]
17	scrotal laceration [54]
18	retroperitoneal operation (sympathectomy) [55]
19	nephropexy [56]
20	tracheal intubation [52]
21	pulmonary resection [51]
22	suprapubic cystostomy [57]
23	scrotal laceration [54]
Other	
1	cardiopulmonary resuscitation [58]

inal cavity. The presence of air/gas can also result from diagnostic procedures such as endoscopy or from thoraco-abdominal surgeries [2].

Pneumoscrotum in Infants/Neonates

Cases of pneumoscrotum are frequently found in middle-aged to geriatric males; however, pneumoscrotum has been reported in infants and neonates as well [27]. Pneumoperitoneum in neonates is not uncommon as it may occur in both healthy and sick newborns [59]. However, free air reaching the neonate's scrotal sac resulting in pneumoscrotum is a rather rare event. Neonates with pneumoscrotum resulting from gastric perforation require surgical intervention [23]. Cochetti et al. [2] found that most newborns present with pneumoscrotum due to gastric and bowel perforation. Trubel et al. [60] reported an infant with tension pneumothorax and tracheal stenosis diagnosed as pneumoscrotum.

Diagnosis

Palpable scrotal air sac is a sign of pneumoscrotum. If the condition is not visually evident and palpable, computed tomography (CT) and X-ray are able to detect the presence of air in the scrotum. Radiological images can define if the gas is in the scrotal wall or within the scrotum and its contents [2, 61].

Historically, the diagnosis of pneumoscrotum has come with finding the source of air or gas leak within the patient. Patients with a history of thoracic or abdominal trauma have frequently been diagnosed with pneumoscrotum [2]. Perforation, biopsy or other varied endoscopic techniques are the common causes of iatrogenic pneumoscrotum. Such procedures were performed either to treat the pneumoscrotum itself or to treat a separate disease. Regardless of the reason, any air source or leak has resulted in swollen scrotal sacs [2, 62].

Radiology

For the purpose of treatment, CT, X-rays and magnetic resonance (MR) scans are performed to identify the primary cause [63]. Radiological imaging is highly useful in finding the source of air coming from thoracic or abdominal source [64].

Infectious activity or bowel herniation is the most common cause of scrotal gas formation. In such circumstances, plain radiographs such as CT and ultrasonography are useful in identifying the exact location of gas [64].

In the case of scrotal emergencies, whether infectious, traumatic or vascular, urgent diagnosis is necessary to prevent further morbidity. Ultrasonography is well equipped in detecting infectious conditions such as epididymitis, emphysematous-epidymoorchitis [65, 66], pyocele and abscess. Doppler ultrasonography is useful to detect vascular conditions. Ultrasonography also evaluates traumatic injuries by indicating signs of rupture. Fournier gangrene is best evaluated under CT scan [67].

MR imaging is a useful aid for diagnosis in case of indefinite findings in scrotal and testicular disease. When initial ultrasonography findings are unclear, MR imaging can serve as useful problem-solving tools. MR can aid in tracing the location of a scrotal mass or differentiating the mass with an inflammatory or vascular defect. Gadolinium-enhanced imaging is helpful to display regions of absent or reduced testicular perfusion [68].

Treatment Options

Etiology of the primary and secondary diseases that results in pneumoscrotum, must be imaged, diagnosed, and treated. Although pneumoscrotum itself is often a benign medical entity, treatment procedures should be carefully based on the cause and patient's physiological conditions. In many cases, management of pneumoscrotum has been nonsurgical with the use of antibiotics and careful observation [44]. If the condition resulted from a separate source (i.e. pneumothorax) more invasive procedures may be required for recovery. Treatment is highly focused upon targeting the primary etiology of pneumoscrotum.

Conclusion

Pneumoscrotum is a rare condition. It is the accumulation of air in the scrotum. Although the condition itself is benign and can be resolved by non-invasive methods, it is essential to identify and treat the primary cause. The cause can be from gas forming bacteria, direct air introduction from scrotal injuries, thoracic or abdominal related conditions. It is important to recognize whether pneumoscrotum is defined as primary and secondary etiologies. Suspected cases must be recognized immediately to prevent further morbidities [2].

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