

Nonscrotal Causes of Acute Scrotum

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Acute scrotum is characterized by intense acute scrotal pain, which may be associated with other symptoms and signs such as abdominal pain, inflammation, and fever. Many pathologic conditions can present in this way, most which involve the scrotal contents. Nonscrotal conditions, however, can rarely present clinically only as acute scrotum: among them, renal colic, aneurysm rupture or other causes of retroperitoneal hemorrhage, primary abdominal or pelvic tumors and metastases, pancreatitis, pelvic inflammation, and muscle injuries. The pathophysiologic characteristics of the clinical presentation, clues for diagnosis, and imaging features of a series of nonscrotal lesions presenting clinically with acute scrotal pain are herein reported and illustrated. In patients presenting with acute scrotal symptoms and normal scrotal ultrasound findings, nonscrotal causes of acute scrotal pain should be considered in the differential diagnosis. Therefore, an ultrasound investigation of the abdomen, groin, and thighs is indicated.

Key Words—acute scrotum; diagnosis; acute scrotum; differential diagnosis; acute scrotum; nonscrotal causes; scrotum; innervation

Received May 10, 2020, from the Department of Radiology, Ospedale Civile di Conegliano, Conegliano, Italy (I.C.); Department of Radiology, Ospedale di Tolmezzo, Azienda Sanitaria Universitaria Friuli Centrale, Tolmezzo, Italy (M.V.); Department of Radiology, King's College Hospital National Health Service Foundation Trust, London, UK (P.S.S.); Department of Radiology, University of Trieste, Ospedale di Cattinara, Trieste, Italy (L.M.M., M.A.C., M.B.); Department of Radiology, Cliniques Universitaires Saint-Luc, Brussels, Belgium (S.V.N.); and Department of Health Sciences, Radiology Section, University of Genoa, Genoa, Italy (L.E.D.). Manuscript accepted for publication July 5, 2020.

Dr Sidhu has received lecture fees from Bracco, Siemens, Samsung, Philips, and Hitachi. All of the other authors of this article have reported no disclosures.

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Abbreviations

US, ultrasound

doi:10.1002/jum.15431

In most cases, acute scrotum is caused by lesions of the scrotal contents. Occasionally, however, nonscrotal disease can present clinically with isolated acute scrotal pain. These patients are first referred for a scrotal ultrasound (US) examination because the scrotum appears to be the area of concern clinically. This could be detrimental, in particular, for a number of life-threatening conditions for which the correct diagnosis may be delayed or even missed if a nonscrotal origin of the pain is not considered.¹

If the sonologist is aware that pain from nonscrotal diseases can refer to the scrotum, and all scrotal structures are normal, the US investigation is extended to the abdomen, groin, and thighs, and further imaging modalities are considered when needed. The complex innervation of the scrotum, involving nervous pathways shared with a variety of other organs, explains why pain from nonscrotal injuries may be referred to the scrotum. In this Pictorial Essay, we describe a number of nonscrotal conditions that may present clinically with acute scrotal pain, with mention of the nervous pathways that can be involved in this clinical presentation.

Anatomy and Pathophysiology

The complex innervation of the scrotum includes somatic and autonomic nerves, closely connected with those innervating other areas of the body. The somatic nerves originate from the lumbar and sacral roots.² The iliohypogastric nerve, in particular, provides sensory innervation to the skin above the pubis; the ilioinguinal nerve innervates the skin of the inner thigh, the penile base, and the anterior

upper portion of the scrotal wall, whereas the genitofemoral nerve innervates the cremaster muscle, the tunica vaginalis, the anterior portion of the scrotal wall, and, through its femoral branch, a small area of the inner thigh. The pudendal and posterior femoral cutaneous nerves innervate the posterior and inferior portions of the scrotal wall, respectively (Table 1 and Figure 1).

The autonomic nervous network arises mainly from the renal, intermesenteric, hypogastric, and pelvic plexuses.^{2,3} Three principal routes are recognized, giving origin to the superior, middle, and inferior spermatic nerves (Table 2 and Figure 2). These complex nervous pathways are largely interconnected and also innervate other regions of the body.

Renal colic is the most common nonscrotal condition that may present with isolated acute scrotal pain, but a variety of other conditions, either spontaneous, traumatic, or iatrogenic, may rarely present in a similar way. A list is reported in Table 3, with mention of the nervous pathways that are likely involved.

Renal Colic

Embryologically, the testes arise in the lumbar region near the kidneys and then descend into the pelvic cavity and through the inguinal canal to end up in the scrotum. Therefore, they share in part both the autonomic and the somatic nerves of the kidney and the ureter.

Renal pain fibers reach the spinal cord through the dorsal nerve roots at levels T11–L2. Aortorenal, celiac, and inferior mesenteric ganglia are also involved. Both the kidney and the upper-middle portion of the ureter receive the branches from the celiac, aortorenal, and superior mesenteric plexuses, and in addition upper-middle portions of the ureter receive

branches from the vagus nerve, whereas the distal ureter and trigone also receive branches from the aortic, inferior mesenteric, hypogastric, and pelvic plexuses. In the lower ureter, pain signals are also distributed through the genitofemoral and ilioinguinal nerves.⁴ Moreover, the genitofemoral nerve originates from the upper part of the lumbar plexus and descends laterally along the psoas major muscle, a route that is anatomically close to the kidney and ureter. In acute renal colic, passage of the calculus may result in inflammation and edema of the ureteral walls, which

Figure 1. Anatomy of the somatic nerves to the scrotum and territories of distribution. The iliohypogastric nerves (in light brown) innervates the skin above the pubis. The ilioinguinal nerve (in red) innervates the femoral triangle after having branched the anterior scrotal nerves, which innervate the penile base and the anterior upper portion of the scrotal wall. The genitofemoral nerve (in darker brown) divides into the genital branch, which innervates the cremaster muscle, the tunica vaginalis, and the anterior portion of the scrotal wall and into the femoral branch, which innervates an area of the inner thigh.

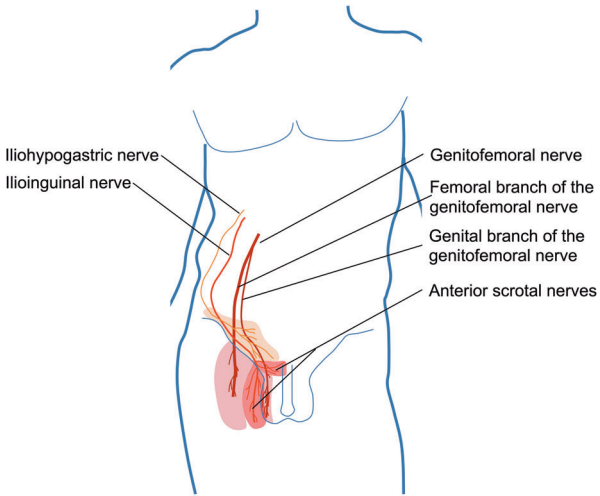


Table 1. Somatic Nerves to the Scrotum

Nerve	Origin	Branches	Distribution
Iliohypogastric	T12–L1		Skin above the pubis
Ilioinguinal	T12–L1	Main trunk	Skin of the inner thigh (femoral triangle)
		Anterior scrotal nerves	Penile base, anterior upper portion of the scrotal wall
Genitofemoral	L1–L2	Genital	Cremaster muscle, tunica vaginalis, anterolateral portion of the scrotal wall
		Femoral	Innervates a small area of the inner thigh
Pudendal nerve	S2–S4	Perineal nerve	Posterior portion of the scrotal wall
Posterior femoral cutaneous nerve	S1–S3	Perineal branch	Inferior portion of the scrotal wall

Table 2. Autonomic Innervation of the Scrotum

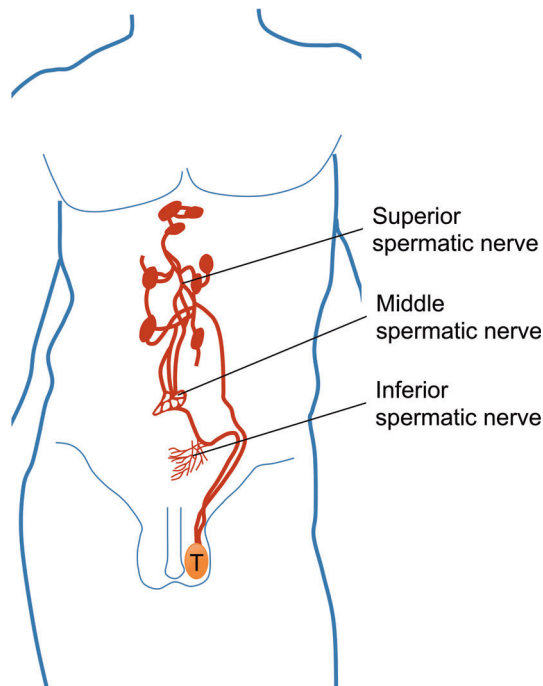
Plexus	Branches	Distribution
Renal and intermesenteric	Superior spermatic nerve ^a	Testis and epididymis, ureter
Hypogastric	Middle spermatic nerve ^b	Deferens, testis and epididymis, ureter
Pelvic (inferior hypogastric)	Inferior spermatic nerve ^c	Seminal vesicle, prostate, bladder, ureter, testis and epididymis

^aAccompanies the testicular and epididymal arteries to the testis and epididymis.

^bTravels along the internal iliac and deferential arteries.

^cTravels along the vas deferens and penetrates the epididymis. Joins the middle-spermatic nerves at the prostate-vesical junction. Some fibers cross over to the contralateral pelvic plexus.

Figure 2. Anatomy of the autonomic innervation of the scrotum. The superior spermatic nerves are composed by fibers from the renal and intermesenteric plexuses. The middle spermatic nerves originate from the superior hypogastric plexus. The inferior spermatic nerves originate from the pelvic plexus. T indicates testis.



stimulate the autonomic innervation of both the ureter and the kidney, as well as the genitofemoral nerve, eventually causing acute scrotal pain (Figure 3).¹

Ruptured Aneurysm

The classic presentation of aortic and iliac aneurysm rupture with abdominal pain, hypotension or shock, and a pulsating mass is not always present. This life-threatening

Table 3. Nonscrotal Causes of Acute Scrotal Pain and Main Nerve Routes Involved

Disease	Nerve Route
Renal colic	Autonomic innervation, genitofemoral nerve
Aortic/iliac aneurysm rupture and other causes of retroperitoneal hemorrhage	Genitofemoral nerve, ilioinguinal nerve
Retroperitoneal tumors	Compression and/or infiltration of the ganglia and the autonomic and somatic nerves
Acute pancreatitis	Spreading of the disease along the retroperitoneum and the spermatic cord with irritation of the autonomic and somatic nerves
Incarcerated hernia	Compression of the genital branches of the ilioinguinal and genitofemoral nerves when entering the spermatic cord
Metastasis	Stretching and compression of the nerves at the level of the spermatic cord, spasms of the cremaster muscle
Acute appendicitis	Spreading of the inflammation to the scrotum via a patent processus vaginalis
Acute prostatitis	Irritation of the pelvic plexus, the pudendal nerve, and the autonomic and somatic nerves to the scrotum
Thigh lesions	Radiating pain from the femoral to the genital branches of the genitofemoral nerve

condition can occasionally present with atypical abdominal pain lasting for weeks, originating from compression by the aneurysmal sac or by retroperitoneal hematoma on the genitofemoral and ilioinguinal nerves (Figure 4).^{5–11} Rarely, isolated acute scrotal pain may be

Figure 3. A 53-year-old man underwent a scrotal US examination for acute scrotal pain. **A**, Color Doppler interrogation of the scrotum shows normal testes. **B**, An extended investigation to the abdomen shows hydronephrosis of the right kidney, suggestive of renal colic. The stone was not identified. **C**, Unenhanced computed tomography shows a small stone (arrowhead) in the pelvic portion of the right ureter.

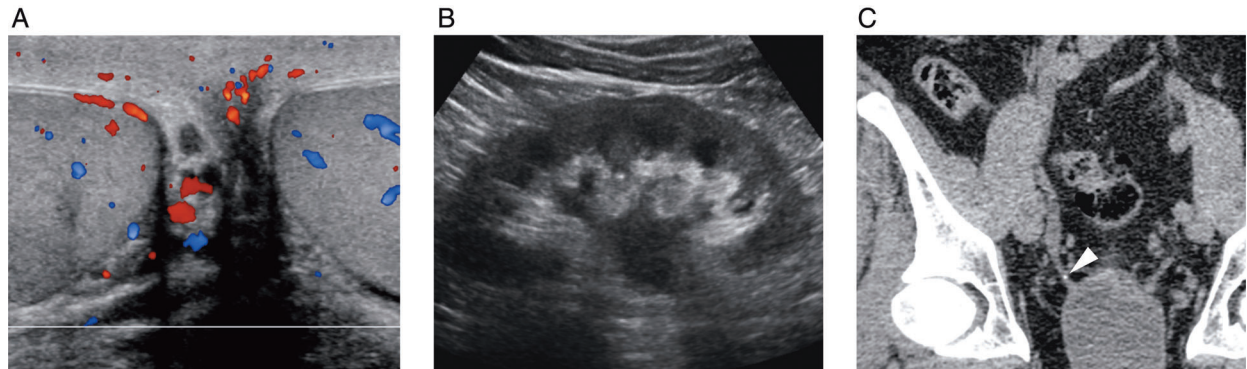


Figure 4. A 65-year-old man presented with left acute scrotal pain lasting 7 hours. **A** and **B**, Scrotal US. The right (**A**) and left (**B**) testes are normal. Bilateral hydroceles are present. **C**, An extended US investigation to the abdomen shows an aortic aneurysm (arrowheads). Further patient questioning revealed that the patient had dizziness when standing, and pain irradiating in the back decreased in the supine position. **D**, Contrast computed tomography shows rupture of the aneurysm (curved arrow) with retroperitoneal hemorrhage prevailing on the left (asterisk).

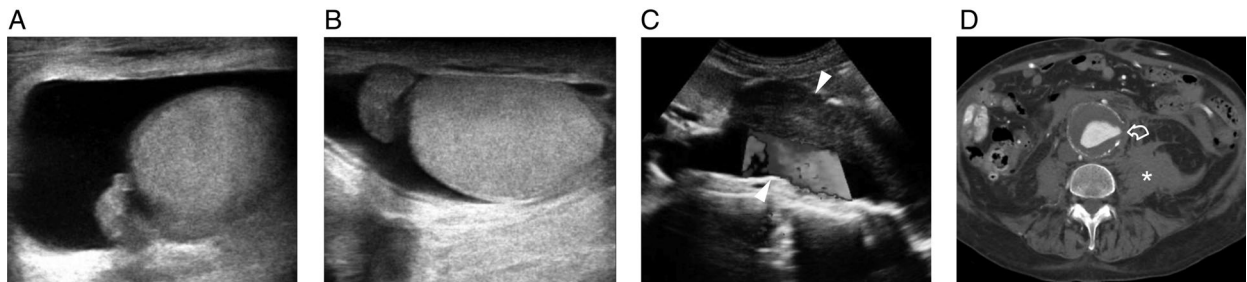
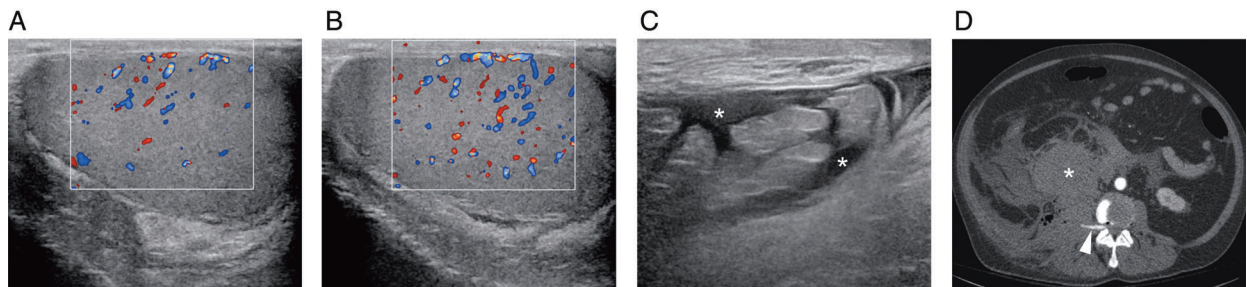


Figure 5. A 60-year-old man developed right acute scrotal pain and swelling in the right inguinal region immediately after endoscopic discectomy for an L2–L3 hernia. Bedside scrotal US was requested emergently. **A** and **B**, Scrotal US. The right (**A**) and left (**B**) testes are normal. **C**, An extended US investigation to the right inguinal region shows fluid dissecting through fat of the inguinal canal (asterisks). **D**, Computed tomographic angiography shows retroperitoneal hemorrhage prevailing on the right (asterisk) caused by iatrogenic disruption of a lumbar artery (arrowhead).



the first clinical presentation of a ruptured aneurysm of the aorta and the common iliac artery. This is the result of spreading of the retroperitoneal hematoma into the inguinal canal, with compression of the spermatic cord caused by direct irritation of the genital nerve.^{9,12}

Other Causes of Acute Pain Referred to the Scrotum

Beyond rupture of abdominal and iliac aneurysms, other causes of spontaneous and iatrogenic retroperitoneal

hemorrhage may rarely present with acute scrotal pain. In children, acute scrotal pain from adrenal hemorrhage^{13,14} or from subcapsular liver hematoma¹⁵ has been described. In adults, retroperitoneal hematoma is usually associated with anticoagulant therapy or iatrogenic causes (Figure 5).^{16,17}

The appearance of chronic pain in the groin, even severe, and diminished skin sensitivity are well-documented unwanted effects of surgical and interventional procedures to the kidney and after hernia repair. Pain may rarely be acute and referred to the testis.¹⁸ This pathologic condition is due to iatrogenic

Figure 6. A 57-year-old man underwent a scrotal US examination for acute scrotal pain on the left side. **A**, Color Doppler interrogation of the scrotum shows normal testes. An extended US investigation to the abdomen revealed a large abdominal mass (not shown). **B**, Axial computed tomography shows a large retroperitoneal lesion (arrowheads) with gross calcifications (asterisk). **C**, Sagittal computed tomography shows the mass (arrowheads) displacing the left kidney (curved arrow) cranially and causing dilatation of the collecting system. The tumor was histologically an extraskeletal osteoblastic osteosarcoma.

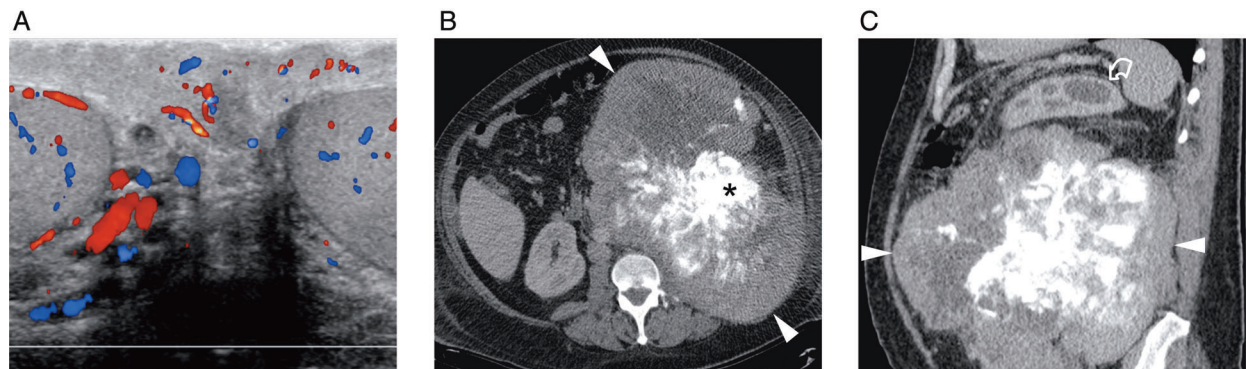
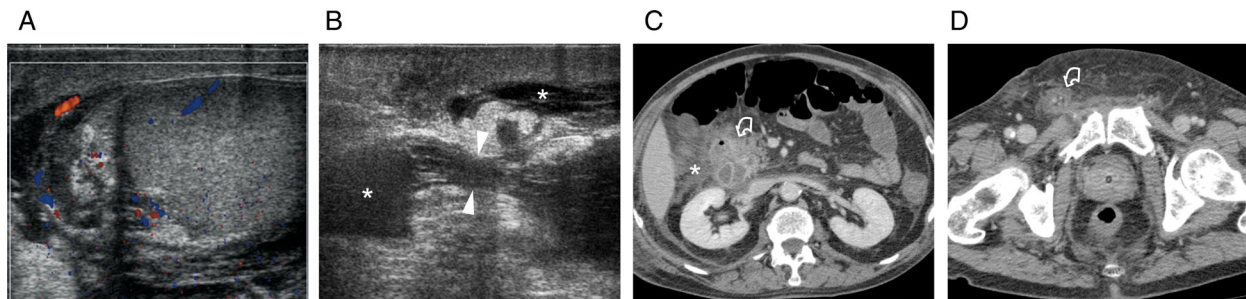


Figure 7. A 77-year-old man underwent a scrotal US examination for acute scrotal pain on the right side. **A**, Color Doppler interrogation of the scrotum shows a normal right testis. **B**, An extended US investigation to the right inguinal region shows the presence of fluid (asterisks) and the spermatic cord (arrowheads) in a sagittal image. **C**, Axial computed tomography in the upper abdomen shows liquefactive necrosis of pancreatic parenchyma (curved arrow) with indistinct margins owing to inflammation, with fat stranding and fluid (asterisk) spreading from the pancreatic region in the right anterior pararenal space. **D**, Axial computed tomography in the pelvis shows stranding of fat tissue spreading around the right spermatic cord (curved arrow).



injury to the genitofemoral nerve and the pelvic plexus.^{18,19}

Retroperitoneal Tumors

The most frequent malignant retroperitoneal tumors are liposarcomas (70%) and leiomyosarcomas (15%). Lymphomas, epithelial tumors arising in the retroperitoneal organs, and metastatic lesions can also be

found.²⁰ Benign histotypes are more often of neuronal (schwannomas and neurofibromas) or paragangliar origin.²¹

Figure 8. A 76-year-old man presented to the emergency department with right acute scrotal pain. He had an already-known inguinal hernia. Color Doppler US of the scrotum revealed a normal right testis (T) and bowel loops (asterisks) from an incarcerated inguinal hernia. Symptoms disappeared after hernia repair.

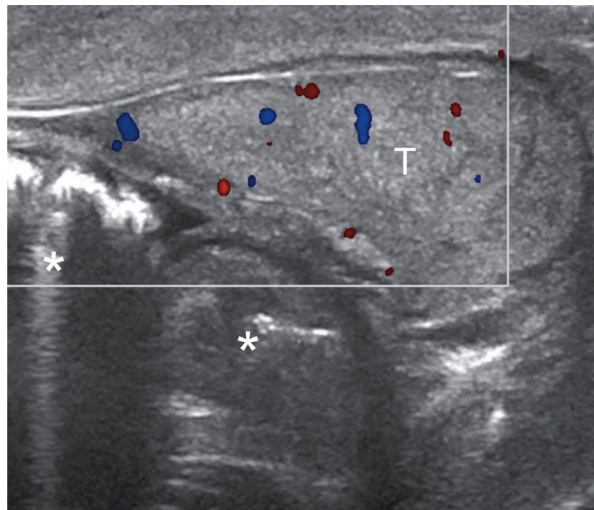


Figure 10. A 70-year-old man presented with right acute scrotal pain. A color Doppler US examination of the scrotum performed to exclude epididymo-orchitis shows a right normal testis and epididymis. No further imaging was performed. The patient had no fever or leukocytosis. His serum concentration of C-reactive protein was mildly elevated (101 mg/L). A further investigation, however, revealed voiding symptoms, and the prostate was swollen and tender on a digital rectal examination. Urinalysis identified more than 205 white blood cells per high-power field. With a working diagnosis of acute prostatitis, the patient was treated with ciprofloxacin for 14 days, with resolution of symptoms.

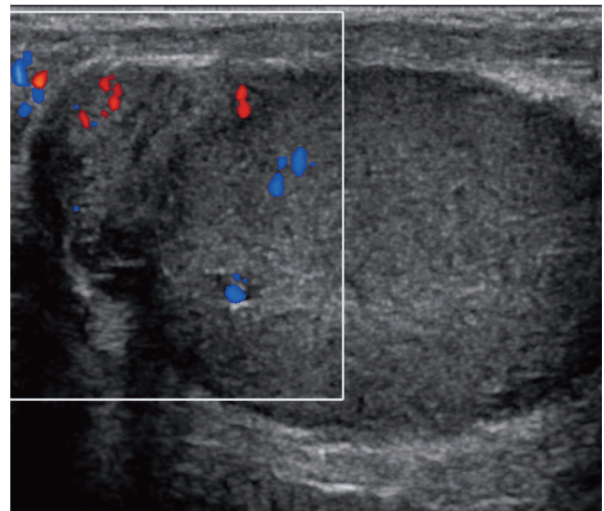
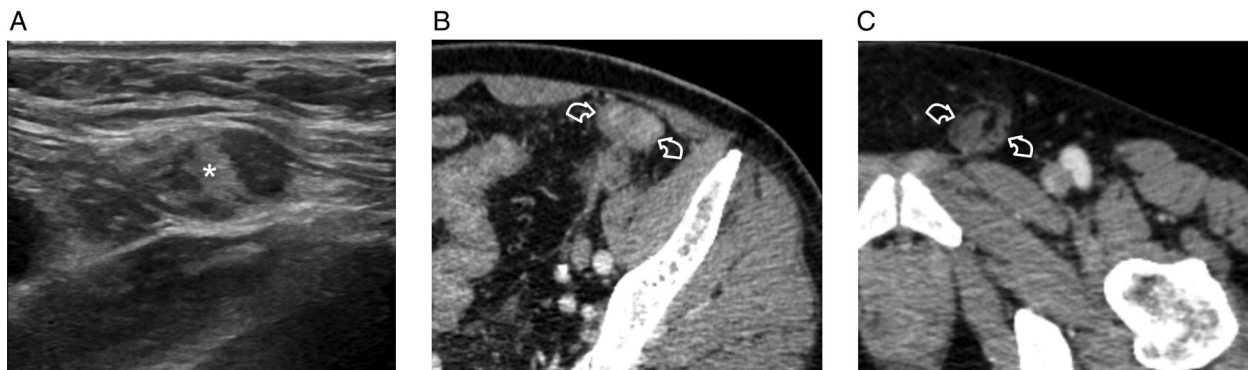


Figure 9. A 65-year-old man underwent a scrotal US examination for acute scrotal pain. Testes were normal (not shown). **A**, An extended US investigation to the left inguinal region shows a small heterogeneous mass involving the spermatic cord (asterisk). **B** and **C**, Axial computed tomography confirms the presence of tumor tissue along the left spermatic cord (curved arrows) above the inguinal canal (**B**), which also spreads below the inguinal canal (**C**) surrounding the cord, running along the layers of the tunica vaginalis. The patient was found to have colorectal cancer with peritoneal and liver metastasis (courtesy of G. Tim Yusuf, BSc, MBBS, FRCR, King's College Hospital).



Often these neoplasms become clinically manifest only when large with nonspecific symptoms such as increased abdominal girth, a palpable mass, and a sensation of swelling.^{22,23} Clinical presentation with acute scrotal pain has been rarely reported,²⁴ probably because of compression, stretching, dislocation, and infiltration of the neuronal ganglia and both the autonomic and somatic routes innervating the testes as well (Figure 6).

Acute Pancreatitis

Acute scrotal pain may rarely present in the setting of pancreatitis.^{25–34} These patients usually have already had severe pancreatitis and then develop acute scrotal pain and swelling, which are misinterpreted as concomitant scrotal disease, such as torsion or inflammation. Isolated presentation of acute pancreatitis with scrotal pain only is extremely rare.³⁵ In patients with pancreatitis, development of acute scrotal symptoms likely occurs from spreading of the exudate, fluid collections, and necrosis of the adipose tissue along the retroperitoneum and spermatic cord, causing irritation of the nervous pathways innervating the scrotum (Figure 7).

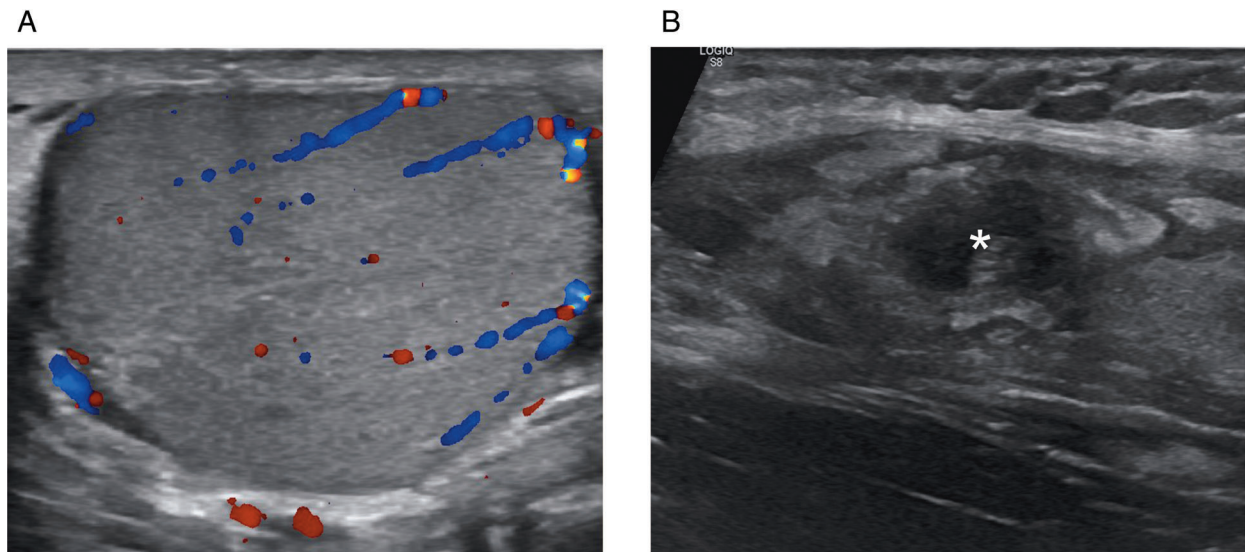
Incarcerated Hernia

Hernia containing omentum or intestinal loops may present with acute scrotal pain in both children^{36–39} and adults.^{40–42} In children, especially if born prematurely, a patent processus vaginalis is usually found. Hydrocele is often associated. Testicular pain is caused by a hernia that induces testicular ischemia or by direct compression of the nerves in the spermatic cord (Figure 8).

Metastases From Abdominal Neoplasms

Scrotal metastases are very rare.⁴³ In most patients with scrotal metastases, the symptoms of the primary neoplasm are prevailing. However, a few cases have been reported of patients with advanced gastric cancer spreading through blood or lymphatic vessels or with peritoneal carcinosis who presented with acute scrotal swelling.^{44–46} Scrotal pain may be associated. Scrotal swelling is usually caused by filling of the cavum vaginalis with ascites through a patent processus vaginalis. Apparently, the right testis is more often affected than the left one, possibly because patency of the vaginal peritoneal duct is more frequent on the right side. Acute pain may be due to direct localization of metastases on the spermatic

Figure 11. A 26-year-old man taking anticoagulant therapy presented with acute scrotal swelling and pain, predominantly on the left side. **A**, A color Doppler interrogation of the scrotum shows a normal left testis. During the scrotal US investigation, the patient revealed that he fell the day before, and discomfort involved not only the scrotum but also the medial aspect of the left thigh (**B**). An extended US investigation to the left thigh reveals injury to adductor muscles (asterisk).



cord, which stretches nerve fibers and contracts the cremaster muscle (Figure 9).

Acute Appendicitis and Prostatitis

The patency of the processus vaginalis allows direct communication between the abdomen and the scrotal sac; therefore, some abdominal conditions that extend to the scrotum can manifest themselves as acute scrotum. This has been well documented in children with acute appendicitis.^{47–50} In adults, scrotal pain may be elicited either through stimulation of the pelvic plexus or by direct irritation of the scrotal innervation.

The prostate, in particular, has a complex sympathetic and parasympathetic innervation that arises from the pelvic plexus and from somatic and autonomic branches of the pudendal nerve. Some fibers run along the seminal tract toward the verumontanum, where they supply the prostatic urethra. Other fibers surround the anterior and lateral surfaces of the prostate, where they penetrate the prostatic capsule and the prostatic gland itself.^{51,52}

Patients with acute prostatitis usually present with fever and chills, difficulty in urinating, cloudy urine, and hematuria. Pain develops in the perineum, the lower back, and often the penis and testes and exacerbates during urination and ejaculation. Swelling of the scrotum may be present. Clinical presentation of acute prostatitis with acute scrotal pain only is unusual (Figure 10).

Thigh Lesions

Although chronic scrotal pain is a known manifestation of athletic pubalgia,⁵³ to the best of our knowledge, presentation with acute scrotal pain has not been previously described. We found a case of injury to the adductor muscles presenting with acute scrotal pain. This might be due to stimulation of the femoral branch of the genitofemoral nerve, with irradiation to the genital branch. In the case we observed, an intramuscular hematoma was present, following a minor trauma, in a patient taking anticoagulant therapy (Figure 11).

Conclusions

A variety of nonscrotal conditions may present clinically with acute scrotal pain, thus entering the differential diagnosis with acute scrotal diseases. The most common of them is renal colic, but severe and life-

threatening conditions, such as aneurysm rupture and other causes of retroperitoneal hemorrhage, can also be encountered. These patients are referred for a scrotal US examination because clinical attention is given primarily to the testis. However, extending the US investigation into the groin and abdomen is advised in patients with acute scrotal pain and normal scrotal contents to assess for nonscrotal causes of the symptoms.

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