The European Research Journal 2024;10(3):286-294 Original Article

DOI: https://doi.org/10.18621/eurj.1386294 *Radiology*

Which pathologies of the penis can be diagnosed with computed tomography? A comprehensive approach to imaging findings

Yeliz Aktürk[1,2], Esra Soyer Güldoğan[2,3], Serra Özbal Güneş[1,2]

[1]Department of Radiology, Ministry of Health Etlik City Hospital, Keçiören, Ankara, Turkey, [2]Department of Radiology, Health Sciences University, Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital, Dıskapı, Ankara, Turkey, [3]Department of Radiology, Turkish Hospital Qatar, Doha, Qatar

ABSTRACT

Objectives: Since there are various benign and malignant diseases of the penis, different imaging methods can be used for diagnosis. Abdominal computed tomography (CT) is not a frequently used imaging method in diagnosing penile pathologies. In an abdominal CT scan performed with the standard technique, the slices are obtained by scanning from the diaphragm's dome to the symphysis pubis's lower edge. Although the whole penis is not always captured, almost all abdomen scans include a portion of the penis. Penile pathologies can be detected with careful evaluation by CT.

Methods: In this study, we aim to investigate incidental penile pathologies detected in abdominal CT performed for other reasons and whether abdominal CT contributes to showing penile pathologies. Therefore, abdominal CTs of 3,698 male patients were re-evaluated for penile pathologies.

Results: The mean age was 52.2 years. Of the CT scans, 38% were obtained due to trauma, 16% were taken for oncological causes, 16% for abdominal pain and acute abdominal pathologies, 10% for urological reasons, 20% for other causes. Penile pathology was detected in 33 (0.83%) of 3968 patients. The patients were divided into four groups according to the pathologies observed in the penis: Traumatic, inflammatory, tumoral, and other findings.

Conclusion: Although CT is not routinely used to diagnose penile pathologies, it may be necessary if the whole penis is included in the examination.

Keywords: Penile imaging, penile pathologies, incidental findings, male health, penile trauma

Various benign and malignant diseases of the penis can be evaluated with different imaging methods. Ultrasonography (US), color Doppler US, computed tomography (CT), magnetic resonance imaging (MRI), and retrograde urethrography are imaging methods that can be employed to confirm the clinical diagnosis, evaluate the disease extent, and help to select the appropriate treatment [1]. US is the first step imaging method in evaluating many penile pathologies [2]. The advantages of the US are that it is low cost and easily accessible, does not contain ionizing radiation, and is a method that can take real-time

Corresponding author: Esra Soyer Güldoğan, MD.,
Phone: +974 5539 7959, E-mail: esra_soyer@hotmail.com

How to cite this article: Aktürk Y, Soyer Güldoğan E, Özbal Güneş S. Which pathologies of the penis can be diagnosed with computed tomography? A comprehensive approach to imaging findings. Eur Res J. 2024;10(3):286-294. doi: 10.18621/eurj.1386294

Received: November 5, 2023
Accepted: January 2, 2024
Published Online: January 22

images. However, it also has disadvantages due to its relatively small field of view, being an operator-dependent examination, and providing limited information on soft tissue pathologies [3, 4]. Because of its high soft tissue resolution, MRI is an excellent diagnostic method when clinical and / or US findings are doubtful or inconclusive. It is a preferred imaging method in surgical planning, cancer staging, and evaluation of penis [2, 3, 5]. Traumatic injuries of the penis are initially visualized by US and MRI. CT is not a frequently used examination in routine penile imaging. However, penile pathologies that can be detected by CT are also quite high [6]. The penile bulbus is an easily recognizable anatomical structure on axial CT images. It is surrounded by a paired crura laterally, corpus cavernosum anteriorly, and levator ani posteriorly [7]. In a routine abdominal CT scan, images are obtained by scanning from the diaphragm's dome to the symphysis pubis's lower edge [8]. So that the glans penis is usually included in the image. We aimed to investigate the presence of incidental pathologies in the penis at the abdominal CT scan performed for different reasons. In addition, we aimed to review the imaging findings of penile pathologies that can be seen on CT examination.

METHODS

Study Design

After obtaining the approval of the required ethics committee, the abdominal CT of male patients aged 18 and over, present in the Picture Archiving Communication System (PACS) between March 2020 and June 2020, a total of 4,116 abdomen CTs were retrospectively re-evaluated. CT scans were taken for different reasons. Regardless of the reason for the scan, images were evaluated blindly to the preliminary information, and the presence of penile pathology was noted. If the patients had more than one CT scan, only the images of the first examination were evaluated and that could not be assessed optimally due to motion artifacts were excluded. One hundred twelve patients who had more than one examination and 12 patients

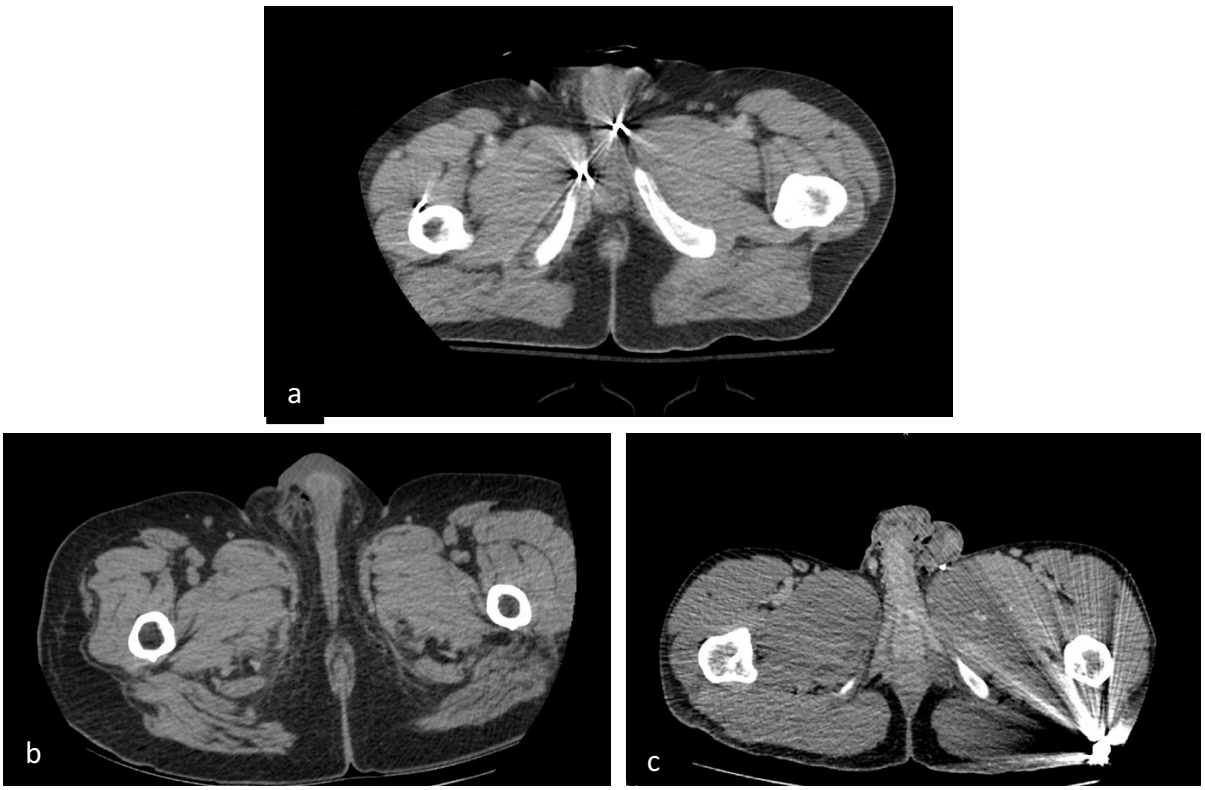

Fig. 1. Axial images. (a) Metallic foreign bodies due to gunshot injury, (b) Hematoma in the anterior of the glans penis, and (c) Air densities near the dorsum penis and contour irregularity due to penile fracture.

who could not be evaluated due to intense motion artifacts were excluded from the study. Also, 24 patients whose CT images did not include the penis at all were excluded from the study. Finally 3,968 patients were included in the study.

Imaging Technique

All abdominal CTs were obtained with the same screening protocol on the same device. The screening was done by scanning the diaphragmatic cupolas to the iliac crest level using a 128-slice CT (Optima CT 660, General Electric Healthcare Systems, Milwaukee, USA). The slice thickness was 5 mm in axial images. All CT scans were obtained during a single breath, covering the area from the level of the diaphragm to the symphysis pubis. If contrast material was administered, it was done according to the following protocol: with non-ionic contrast agents (1.5-2 mL/kg) at the portal venous phase (65-70 s). All CT images were reconstructed using an algorithm suited to soft-tissue analysis with the medical image processing software (AW Volume Share 5).

CT Evaluation

CT evaluation was performed by two radiologists, one 10 years and the other 15 years experienced in tomography. Penile pathologies were divided into four groups: Traumatic, inflammatory, and tumoral. The distribution of patients with penile pathology according to age groups was evaluated. In addition, the frequency of association of penile pathologies with abdominal pathologies was investigated.

Statistical Analysis

Continuous data expressed as the mean ± standard deviation or median (interquartile range [IQR]) were analyzed using a t or Mann-Whitney U test. Statistical analysis was conducted with statistical software (SPSS, version 21.0; SPSS Inc, Chicago, IL, USA).

RESULTS

Between March 2020 and June 2020, 3968 male patients aged 18 and over underwent abdominal CT. The ages of the patients ranged from 18 to 84 years. The mean age was 52.2 years. Of the CT scans, 38% were obtained due to trauma, 16% were taken for oncological causes (suspicion of malignancy, newly diagnosed malignancy, and follow-up), 16% for abdominal pain and acute abdominal pathologies, 10% for urological reasons (renal cyst, benign prostate hypertrophy, hematuria), 20% for other causes.

Penile pathology was detected in 33 (0.83%) of 3968 patients. The patients who had penil pathologies were divided into four groups according to the pathologies observed in the penis: Traumatic, inflammatory, tumoral, and other findings.

There were four (0.1%) patients with penile

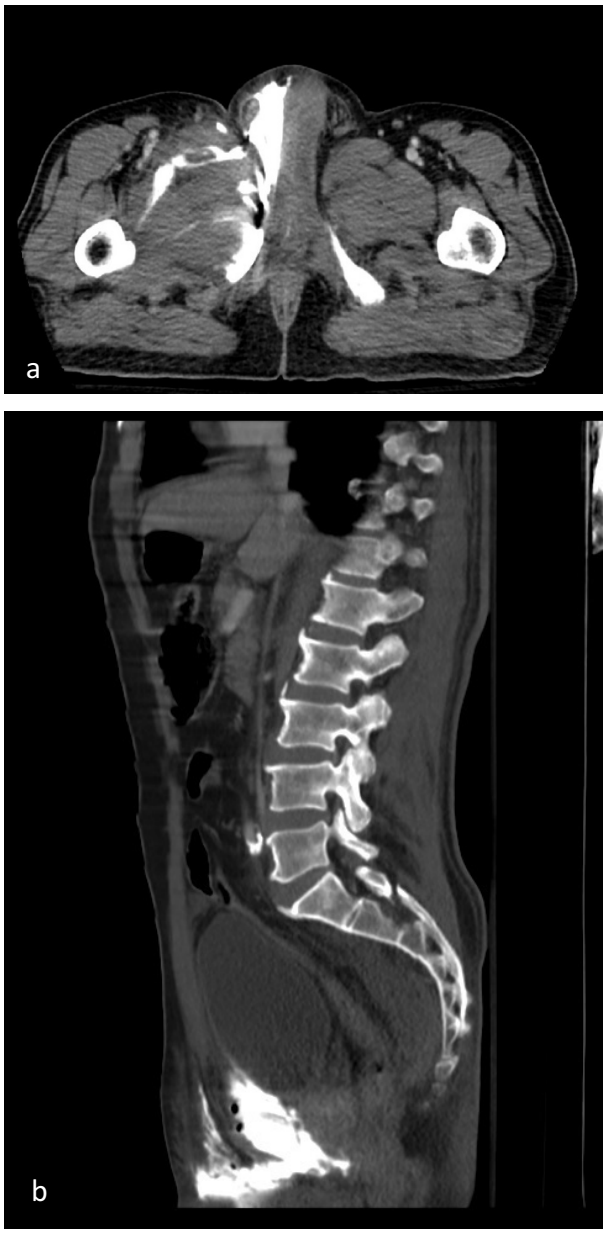

Fig. 2. Axial (a) and sagittal (b) image. Contrast material accumulated in the perineum and near the penis due to type III urethral injury.

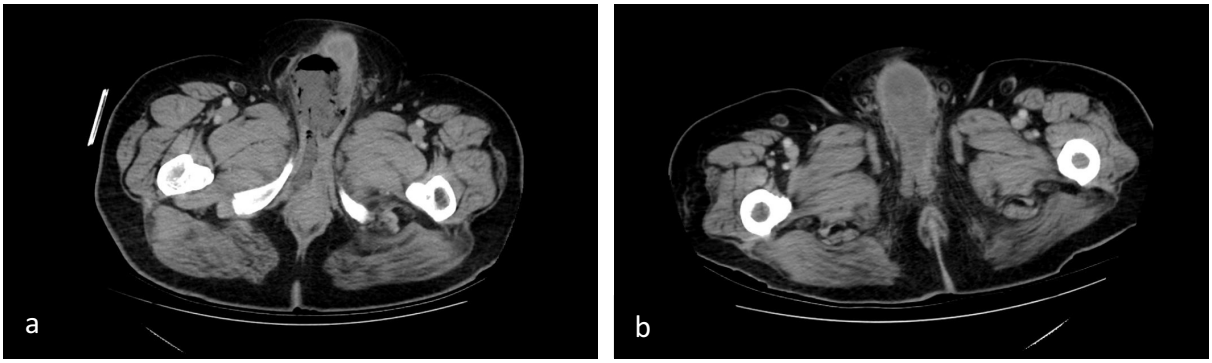

Fig. 3. Axial images. (a) Air densities consistent with necrotizing infection in the glans penis and scrotum and (b) Edematous and heterogeneous appearance consistent with balanitis on the glans penis.

trauma findings in the trauma patients group. Three patients had signs of penetrating penile trauma, aged 33 to 41 years. CT scannings of these three patients revealed air densities near the dorsum penis, metallic foreign bodies due to gunshot injury, and hematoma in the anterior of the glans penis (Figs. 1a and 1b) and one of them had penile fracture (Fig. 1c). In a 45-year-old trauma case, there was no traumatic injury of the penis, but contrast material accumulated in the perineum and near the penis due to type III urethral injury (Fig. 2).

There were four (0.1%) patients in the inflammatory pathologies group. Their age ranged from 54 to 68 years. In three cases, there were inflammatory heterogeneities in the skin and subcutaneous tissue, abscess formation in the perineal area and adjacent to the dorsum penis. Two of four cases had air densities consistent with necrotizing infection in the glans penis and scrotum (Fig. 3a). One patient had an edematous and heterogeneous appearance consistent with balanitis on the glans penis (Fig. 3b).

Two (0.05%) patients were classified in the tumoral pathologies group. Penile squamous carcinoma was detected in a 75-year-old patient who had mild

Fig. 4. Axial image shows a metastatic mass lesion with contrast enhancement at the penile crura.

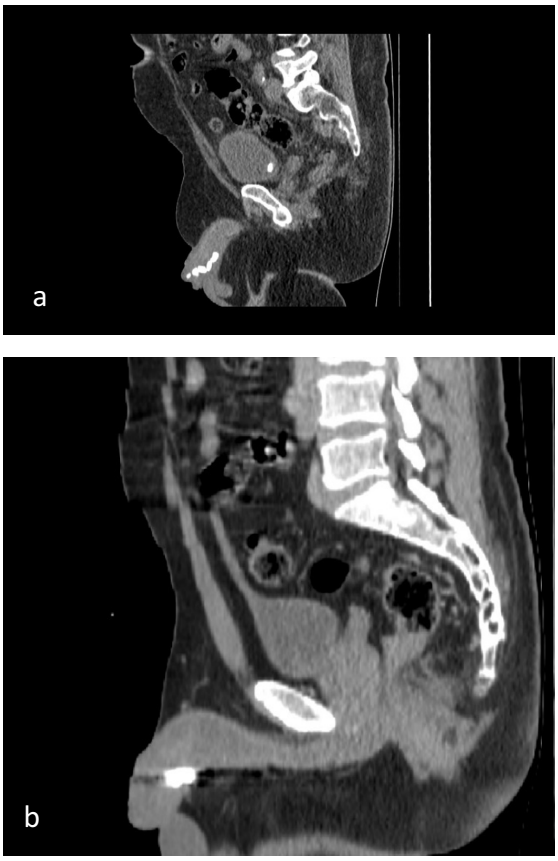

Fig. 5. Sagittal images. (a) Multiple urinary stones in the penile urethra and the bladder and (b) A metallic density due to a foreign body in the glans penis.

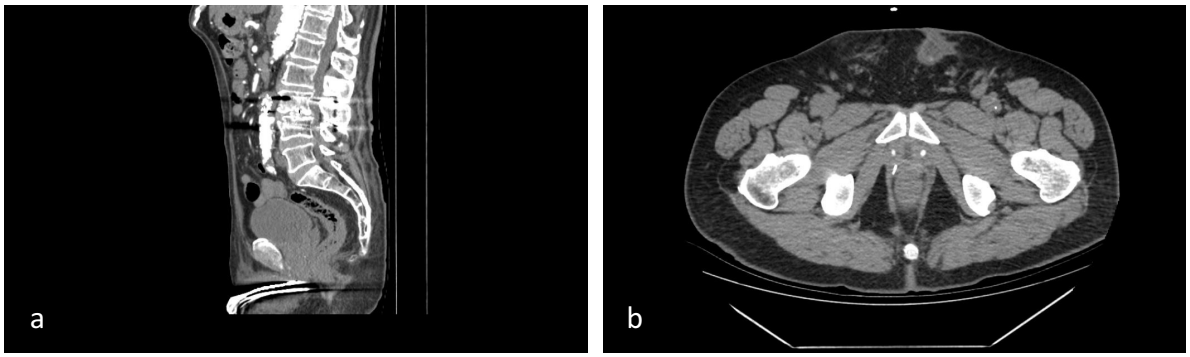

Fig. 6. Sagittal (a) and axial (b) image. (a) Penile prosthesis and (b) Abscess showed cutaneous extension and inflammatory changes around it.

skin thickening and contrast enhancement at the corpus cavernosum. There was an enlarged inguinal lymph node on the right side, suggesting metastasis. In a 68-year-old case, in the abdominal CT scan that was performed due to bladder carcinoma during follow-up, there was a metastatic mass lesion with contrast enhancement at the penil crura (Fig. 4).

In the other findings group, there were 23 (0.57%) patients. Three (0.075%) cases aged 36 and 65 had urinary stones in the penile urethra. In the other findings group, three cases between ages of 36 and 65 had urinary stone in the penile urethra and one of them has hydronephrosis (Fig. 5a). A 50-year-old patient had a metallic density due to a foreign body in the glans penis (0.025%) (Fig. 5b). Four (0.1%) patients between the ages of 49 and 77 had penile prostheses. In one (0.025%) of these cases, there was an abscess adjacent to the catheter of the prosthesis. In one of these cases, there was an abscess adjacent to the catheter of the prosthesis with periferal contrast enhancement. The abscess showed cutaneous extension and there were inflammatory changes around it (Figs. 6a and 6b). Linear calcifications were observed in the tunica albuginea in 15 (0.37%) cases aged 52 to 80 (Fig. 7).

Fig. 7. SLinear calcifications in the tunica albuginea.

Findings observed in the traumatic, inflammatory, tumoral pathologies and other findings groups are summarized in Table 1 and Table 2.

DISCUSSION

Different imaging techniques are used in penile imaging according to pathologies [9]. Ultrasound is the first-line imaging modality in penile imaging that can show anatomy and blood flow, detect abnormalities such as penile masses or plaques, and evaluate conditions such as priapism or erectile dysfunction. It is a fast, noninvasive imaging method that is easily accessible in many places, if not all over the world. Doppler ultrasound can be used to evaluate erectile dysfunction by measuring penile blood flow during different stages of an erection. Doppler ultrasound is particularly useful in diagnosing vascular conditions, such as arterial insufficiency or venous leakage. MRI is useful for evaluating complex penile conditions and provides excellent soft tissue resolution but may require the use of contrast agents for better visualization. CT imaging is typically reserved for investigating penile trauma, assessing the extent of penile fractures, or evaluating suspected penile cancer.

Focal or diffuse penile induration is a common problem in urological practice. It often occurs due to

Table 1. **Penile pathologies detected on CT**

Penile pathologies	Number of cases	Age (years) (min-max)	CT findings
Traumatic	4 (0.1%)	33-41	Air densities, metallic foreign bodies, hematoma, contour irregularity in the penis
Inflammatory	4 (0.1%)	54-68	Heterogeneities in the skin and subcutaneous tissue, abscess in the perineal area, air densities in the glans penis and scrotum, edematous and heterogeneous appearance on the glans penis
Tumoral	2 (0.05%)	68-75	Skin thickening and contrast enhancement at the corpus cavernosum, enlarged inguinal lymph node, mass lesion with contrast enhancement
Other findings	23 (0.57%)	36-80	Findings regarding foreign bodies, penile prosthesis and calcifications

CT=computed tomography

Peyronie's disease. However, other benign and malignant pathologies are also included in the differential diagnosis. In addition to a physical examination, imaging modalities are often required to confirm the diagnosis and assess the extent of the disease. US and MRI are the most commonly used methods. In addition, retrograde urethrography and CT can be used in selected cases [9]. Peyronie's disease is a condition in which fibrous tissue plaques form in the tunica albuginea, leading to penile deformity and shortening [10]. The diagnosis is made by questioning the patient's medical history, autophotography, and palpation of the plaques. Imaging is needed to evaluate the extension of the plaques, the involvement of the penile septum, and the relationship of plaques with penile vascular structures [11]. Although calcified plaques can be diagnosed better with US in Peyronie's disease, MRI is more valuable than US in detecting non-palpable plaques and evaluating their size [1]. Albugineal calcifications are sometimes difficult to evaluate [12]. CT can be used to evaluate non-calcified plaques [13]. CT is not employed in the investigation of Peyronie's disease. If CT is performed for other reasons, plaques may be seen incidentally. Our incidental penile calcific plaque detection rate was 0.37%. Case ages ranged from 52 to 80.

Imaging is essential in the initial evaluation, treatment planning, and patient follow-up in penile carcinoma [14]. Because of its high soft tissue contrast and spatial resolution, MRI is used more than in the US in both defining primary penile malignancies and showing lymph node involvement (1). MRI is used in T

Table 2. **Distribution of pathologies in the other findings group**

Penile pathologies	Number of cases	Age (years) (min-max)	CT findings
Urinary stone	3 (0.075%)	36-65	Urinary stone in the penile urethra, hydronephrosis
Foreign body	1 (0.025%)	50	Metallic density in the glans penis
Penile prostheses	4 (0.1%).	49-77	Abscess near the catheter of the prosthesis, a cutaneous extension of inflammatory changes
Penile calcifications	15 (0.37%)	52-80	Linear calcifications in the tunica albuginea
Total	23 (0.57%)		

CT=computed tomography

staging of the primary tumor and screening for local recurrence. CT and positron emission tomography (PET) / CT are useful in scanning regional nodal and distant metastases [14]. CT is usually not indicated in newly diagnosed penile cancers without palpable inguinal lymph nodes [15]. Penile squamous carcinoma was detected in one of our cases. This patient had mild skin thickening and contrast enhancement at the corpus cavernosum. An enlarged inguinal lymph node on the right side suggests metastasis. In one patient, an abdominal CT scan was performed due to bladder carcinoma during follow-up, and there was a metastatic mass lesion showing contrast enhancement in the penile crura.

Penile prostheses are MRI-compatible, so MRI is increasingly used to evaluate postoperative changes [1]. However, CT is cheaper and more usable for some patients, especially in emergencies, post-surgical hematoma, and suspected infection [16]. In the infection of penile prostheses, thickening of the skin, soft tissue swelling, and fat stranding are seen on CT. In cases with abscess, a rim-like enhancing fluid collection with or without gas is detected. Irregularity and ulceration of the skin may accompany [16, 17]. In our case with a penile prosthesis, there was an abscess with peripheral contrast enhancement with cutaneous extension in the left inguinal region adjacent to the catheter and inflammatory changes around it.

Genital emergencies are rare in men; therefore, the role of imaging is essential. First, it is necessary to know the specific imaging findings of the injuries [6]. Contrast-enhanced abdominal and pelvis CT is the gold standard for abdominal trauma imaging [18, 19]. However, the US initially visualizes traumatic injuries to the penis and scrotum. It should be evaluated whether the tunicae albuginea surrounds the penile corpora and testis seminiferous tubules. Herniation of the contents and discontinuity of the tunica albuginea make the diagnosis of rupture [6]. The bulbocavernous muscle is a small muscle associated with the corpus spongiosum. It is the ventral muscle of the penis and surrounds the bulbus. In cases of pelvic fracture accompanied by urethral injury, it has been reported that this usually symmetrical midline structure has asymmetry in its outer edges, contour, or size [18]. Because the urethra is longer in men, urethral trauma is more common in men than in women. Posterior urethral injury occurs in the membranous and prostatic urethra. A straddle-type injury usually causes bulbar urethral injuries, while penile urethral damage is associated with penile fracture [20, 21]. Even if the damage is not in the penile urethra, pathological findings around the penis can be seen on abdominal CT. One of our post-traumatic patients had a type III urethra injury. There was contrast media accumulation in the perineum and near the penis due to injury to the urogenital diaphragm and the membranous urethra extending to the proximal bulbous urethra.

Different types of foreign bodies have been reported in the urethra. Although the presentation of foreign bodies in the lower urinary system varies, dysuria and hematuria are the most common symptoms. The severity of the clinical situation depends on the nature of the foreign body and, more importantly, the time of the medical intervention. Therefore, early recognition and removal of foreign bodies are crucial [22]. US pelvic roentgenogram or CT can be used to evaluate the shape and position of a foreign body [23]. In our cases, the foreign bodies observed in the penis and its neighborhood were metallic foreign bodies due to gunshots.

Inflammation of the glans penis is defined as balanitis, and inflammation of the prepuce as posthitis. Balanitis is a descriptive term that includes various conditions, and sometimes a biopsy may be required to rule out premalignant diseases [24]. Penile cellulitis and balanitis an be treated with antibiotics, while penile abscess and infection of the corpus cavernosum can be life-threatening [10]. US is important in excluding corpus cavernosum involvement and abscess in patients with inflammation [25]. In severe inflammatory conditions, urgent CT or MRI is required for the extension of the infection to the perineum, abdominal wall, and fasciae [26]. As with abscesses elsewhere in the body, fluid accumulation is seen on CT in penile abscesses. The fluid collection sometimes includes air densities. In addition, the surrounding adipose tissue has edema and environmental contrast enhancement. Imaging allows the identification of the location of the abscess and its relationship to nearby anatomical structures and guides drainage [10]. Fournier's gangrene is a genitourinary necrotizing fasciitis that can be fatal if not quickly diagnosed and surgically debrided. It is typically a male-predominant disease [27]. Although usually diagnosed clinically, CT may be required to assess the extent of the disease or to plan surgical treat-

ment. The presence of fascial gas and inflammation findings on CT should suggest the diagnosis [28]. Two of our patients had rectal fluctuation and fever, and there were signs of necrotizing infection on CT.

Limitations

The limitations of our study are that the object of the tomography scan is not aimed at detecting penile pathology and as with all retrospective studies, there may be deficiencies in patient data. Although CT can diagnose many penile pathologies, it does not seem possible to replace ultrasound in diagnosis due to the radiation dose. However, due to its high diagnostic sensitivity, it should be kept in mind that BT is a diagnostic test for penile pathology in cases where ultrasound cannot be reached and in patients who will undergo pelvic tomography for any other reason.

CONCLUSION

Although CT is not routinely used in the diagnosis of penile pathologies, careful evaluation of the penis included in the examination may be important in the diagnosis. In particular, the penis should be included pelvic tomography scans especialy in emergency, and it should not be forgotten that CT can reveal the diagnosis of many pathologies despite known of the low soft tissue resolution in penile imaging.

Authors' Contribution

Study Conception: YA; Study Design: YA, ESG; Supervision: SÖG; Funding: YA; Materials: ESG, YA; Data Collection and/or Processing: ESG, YA; Statistical Analysis and/or Data Interpretation: ESG, YA; Literature Review: ESG; Manuscript Preparation: ESG and Critical Review: SÖG, YA, ESG.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The authors disclosed that they did not receive any grant during conduction or writing of this study.

The institution where study was developed

Department of Radiology, Health Sciences University Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital, Dıskapı, 06130, Ankara, Turkey.

REFERENCES

1. Shenoy-Bhangle A, Perez-Johnston R, Singh A. Penile imaging. Radiol Clin North Am. 2012;50(6):1167-1181. doi: 10.1016/j.rcl.2012.08.009.
2. Kirkham A. MRI of the penis. Br J Radiol. 2012;85 Spec No 1(Spec Iss 1):S86-93. doi: 10.1259/bjr/63301362.
3. Parker RA 3rd, Menias CO, Quazi R, et al. MR Imaging of the Penis and Scrotum. Radiographics. 2015;35(4):1033-1050. doi: 10.1148/rg.2015140161.
4. Pretorius ES, Siegelman ES, Ramchandani P, Banner MP. MR imaging of the penis. Radiographics. 2001;21 Spec No:S283-S298. doi: 10.1148/radiographics.21.suppl_1.g01oc24s283.
5. Tu LH, Spektor M, Ferrante M, Mathur M. MRI of the Penis: Indications, Anatomy, and Pathology. Curr Probl Diagn Radiol. 2020;49(1):54-63. doi: 10.1067/j.cpradiol.2018.12.004.
6. Avery LL, Scheinfeld MH. Imaging of penile and scrotal emergencies. Radiographics. 2013;33(3):721-740. doi: 10.1148/rg.333125158.
7. Wallner KE, Merrick GS, Benson ML, Butler WM, Maki J, Tollenaar BG. Penile bulb imaging. Int J Radiat Oncol Biol Phys. 2002;53(4):928-933. doi: 10.1016/s0360-3016(02)02805-5.
8. Hodler J, Kubik-Huch RA, von Schulthess GK, editors. Diseases of the Abdomen and Pelvis 2018-2021: Diagnostic Imaging - IDKD Book [Internet]. Cham (CH): Springer; 2018.
9. Bertolotto M, Pavlica P, Serafini G, Quaia E, Zappetti R. Painful penile induration: imaging findings and management. Radiographics. 2009;29(2):477-493. doi: 10.1148/rg.292085117.
10. El-Sakka AI, Hassoba HM, Pillarisetty RJ, Dahiya R, Lue TF. Peyronie's disease is associated with an increase in transforming growth factor-beta protein expression. J Urol. 1997;158(4):1391-1394.
11. Bertolotto M, Coss M, Neumaier C. US evaluation of patients with Peyronie's disease. In: Bertolotto M, ed. Color Doppler US of the penis. Berlin, Germany: Springer-Verlag, 2008: pp. 61-69.
12. Vosshenrich R, Schroeder-Printzen I, Weidner W, Fischer U, Funke M, Ringert RH. Value of magnetic resonance imaging in patients with penile induration (Peyronie's disease). J Urol. 1995;153(4):1122-1225.
13. Al-Thakafi S, Al-Hathal N. Peyronie's disease: a literature review on epidemiology, genetics, pathophysiology, diagnosis and work-up. Transl Androl Urol. 2016;5(3):280-9. doi: 10.21037/tau.2016.04.05.
14. Suh CH, Baheti AD, Tirumani SH, et al. Multimodality imaging of penile cancer: what radiologists need to know. Abdom Imaging. 2015;40(2):424-435. doi: 10.1007/s00261-014-0218-6.
15. Clark PE, Spiess PE, Agarwal N, et al; National Comprehensive Cancer Network. Penile cancer: Clinical Practice Guidelines in Oncology. J Natl Compr Canc Netw. 2013;11(5):594-615. doi: 10.6004/jnccn.2013.0075.
16. Chou HL, Mohsen NA, Garber BB, Feldstein DC. CT imaging of inflatable penile prosthesis complications: a pictorial essay. Abdom Radiol (NY). 2019;44(2):739-748. doi: 10.1007/s00261-

018-1764-0.
17. Darouiche RO. Device-associated infections: a macroproblem that starts with microadherence. Clin Infect Dis. 2001;33(9):1567-1572. doi: 10.1086/323130.
18. Ali M, Safriel Y, Sclafani SJ, Schulze R. CT signs of urethral injury. Radiographics. 2003;23(4):951-963. doi: 10.1148/rg.234025097.
19. Dane B, Baxter AB, Bernstein MP. Imaging Genitourinary Trauma. Radiol Clin North Am. 2017;55(2):321-335. doi: 10.1016/j.rcl.2016.10.007.
20. Brandes S. Initial management of anterior and posterior urethral injuries. Urol Clin North Am. 2006;33(1):87-95, vii. doi: 10.1016/j.ucl.2005.10.001.
21. Rosenstein DI, Alsikafi NF. Diagnosis and classification of urethral injuries. Urol Clin North Am. 2006;33(1):73-85, vi-vii. doi: 10.1016/j.ucl.2005.11.004.
22. Mak CWH, Cho CL, Chan WKW, Chu RWH, Law IC. Per urethral insertion of foreign body for erotism: case reports. Hong Kong Med J. 2019;25(4):320-322. doi: 10.12809/hkmj177044.
23. Gunasekaran K, Murthi S. Unusual metallic penile foreign body. BMJ Case Rep. 2017;2017:bcr2017219377. doi: 10.1136/bcr-2017-219377.
24. Edwards SK, Bunker CB, Ziller F, van der Meijden WI. 2013 European guideline for the management of balanoposthitis. Int J STD AIDS. 2014;25(9):615-626. doi: 10.1177/0956462414533099.
25. Pearle MS, Wendel EF. Necrotizing cavernositis secondary to periodontal abscess. J Urol. 1993;149(5):1137-1138. doi: 10.1016/s0022-5347(17)36321-8.
26. Kickuth R, Adams S, Kirchner J, Pastor J, Simon S, Liermann D. Magnetic resonance imaging in the diagnosis of Fournier's gangrene. Eur Radiol. 2001;11(5):787-790. doi: 10.1007/s003300000599.
27. Singh A, Ahmed K, Aydin A, Khan MS, Dasgupta P. Fournier's gangrene. A clinical review. Arch Ital Urol Androl. 2016;88(3):157-164. doi: 10.4081/aiua.2016.3.157.
28. Ballard DH, Raptis CA, Guerra J, et al. Preoperative CT Findings and Interobserver Reliability of Fournier Gangrene. AJR Am J Roentgenol. 2018;211(5):1051-1057. doi: 10.2214/AJR.18.19683.