J. Expt. & Clin. Anat. 5(1): 36-40 (2006).

JECA

Short Review
Penile Ultrasonography: Anatomy and Scanning Protocols

[1]*A.C.UGWU , [2]O.A. EGWU AND [2]K.N.OVUOBA
[1]Department Of Radiology, Federal Medical Centre, Abakaliki, Ebonyi State, Nigeria
[2]Department Of Anatomy, Ebonyi State University, Abakaliki, Nigeria
*Author for correspondence

ABSTRACT

Objective: This article is intends to provide a short review of the normal anatomy of the Penis, Scanning protocols and various imaging manifestations of penile disorders. Penile anatomy, cases of Penile tumour and trauma that present pertinent acoustic signatures are reviewed. Ultrasonography in conjunction with colour and pulsed Doppler imaging is important in the assessment of penile disorders. The normal sonographic anatomy of the penis, scanning techniques and various penile disorders are discussed. Sonography (particularly with Colour Doppler Sonography) is a useful method for the evaluation of penile anatomy and also investigating the pathologic consequences of trauma and tumours.

Keywords: Penile anatomy; Penile Trauma; Ultrasonography.

The study of penile tumours by sonography has proved to be of great importance in the treatment of these lesions (Nakayama et al, 1997; Dorak et al, 1992; Horenblas et al, 1994; Pavlica and Barrozi, 1998 and Benson et al, 1991) because sonography allows accurate measurement of lesions and evaluation of the anatomical relationships of the tumour to penile structures.

Sonography gives a more accurate estimate of penile tumour extent than physical examination can do and hence its routine use should enable preservation of more of the Penis (Agrawal et al, 2000). Sonography with colour Doppler sonography is a useful imaging method for evaluating penile anatomy and various pathologic features with penile trauma (Shweta et al, 2005). B-mode imaging combined with Duplex Doppler interrogation provides valuable information in assessment of penile masses and fractures. This article reviews the normal anatomy of the penile and the use of Ultrasonography in the evaluation of penile masses and trauma.

Normal Anatomy: The Penis is composed of three (3) elongated masses of spongy tissue: Two dorsally located Corpus Cavernosa (CC) and One ventrally located Corpus Spongiosum (CS). The 2 Corpora Cavernosa are enclosed in a fibrous sheath called the Tunica albuginea (TA), which also covers the Corpus Spongiosum (CS). The CS is traversed by the Urethra. From the TA arise trabeculae composed of elastic and collagen fibres and smooth muscle cells that divide the CC into irregularly arranged cavernous spaces lined by endothelium. The Glans Penis (GP) is formed by a somewhat conical expansion of the CS, which projects dorsally over the CC. As the Urethra traverses the CS, it receives support and the expulsion of semen is enhanced. The Penile skin is relatively thin and dark and overlapping the GP, it is folded to form the prepuce. Beneath the skin is the superficial penile fascia. Its deepest layer is condensed to form the Penile Fascia of buck, which surrounds the three Corpora.

Blood supply to the Penis is via the Dorsal and Deep arteries of the Penis, which are the terminal branches of internal pudendal artery. The Dorsal artery supplies the prepuce and GP. The Deep or Cavernosal artery gives out branches that are convoluted and dilated (Halicine arteries), which subsequently divide into smaller vessels that communicate with the spaces of the CC. Venous blood is returned by the venous plexus beneath the TA. Emmisary veins perforate the TA and blood is drained by the venae circumflexae into the deep dorsal veins (Dogra and Bhatt, 2004 and Sadeghi-Nejad et al, 2004).

Scanning Protocols For The Penis: Sonographic examination for the penis is

performed with the patient in either the supine or lithotomic (frog leg) position with the penis lying on the anterior abdominal wall or supported with towels between the thighs. High frequency (7.5 to 12 MHz) linear array transducer is used to obtain highly resolution imges of the penis (Dogra and Bhatt, 2004; Sadeghi-Nejad, 2004, 2004 and Bertolotto and Neumaier, 1999). A sufficient amount of ultrasound coupling gel should be used on the surface of the penis to get good quality images. Much compression by the probe is avoided especially in traumatized patients. The examination is performed in transverse and longitudinal planes starting at the level of the GP and moving down to the base of the penis (Benson et al, 1991 and Desser et al, 1999). Transperineal approach could be used to assess the base of the penis. The two CC are homogenous in echotexture and identified as two-hypoechoic circular structures. The TA is visualized as a linear hyperechoic structure covering the CC (Benson et al, 1991 and Desser et al, 1999). The CS is often compressed and difficult to visualize optimally from the ventral aspect. Colour Doppler examination of the penis should be performed in both transverse and longitudinal planes. Peak systolic velocities of the deep arteries should be recorded. Carvenosal artery velocities in healthy volunteers measure 10 to 15cm/s in the non-erect condition (Benson et al, 1991 and Schwartz et al, 1989).

Sonourethrography: This refers to the ultrasound examination of the urethra. It can be either through a saline infusion or gel distension. Distension can be achieved by either an antegrade or a retrograde approach. High-resolution linear array transducer as used in penile examination is used for urethral examination.

The antegrade technique requires the patient voiding and if a full stream is achieved, a clamp is placed at the distal end of the penis to preserve distension. A traditional retrograde technique is the introduction of normal saline solution into the urethra via either a Foley catheter or a syringe placed directly in the urethral meatus (Pavlica et al, 2003). Alternatively, intraluminal lubricant and anesthetic sonourethrography (Benson et al, 1991; Pavlica et al, 2003; Desser et al, 1999). It is injected directly into the meatus until the urethra appears fully distended on sonography (Pavlica et al, 2003). After distension, a flexible penile clamp is applied to GP to maintain urethral distension (Benson et al, 1991; Pavlica et al, 2003). The retrograde technique is preferred. The Penile Urethra is examined from the dorsal surface of the penis; if needed, additional scanning from the ventral surface can also be performed (Shweta et al, 2005). The distal bulbar urethra can be imaged transperitoneally (Benson et al, 1991). Longitudinal scans are more useful than transverse scans because of their wide field of view. Transverse scans are used to further examine detected focal lesions (Pavlica et al, 2003).

The posterior urethra can be evaluated by a transrectal approach similar to the study of prostate and anal canal (Dorak et al, 1992; Rifkin, 1984). The transducer is inserted into the rectum and directed interiorly towards the prostate, and the patient is asked to urinate. The main disadvantage of this approach is the difficulty of patient's urination (Shweta et al, 2005). This problem can be solved changing the patient's position to upright or by using a special tool with a hole at the center through which the probe can be inserted into the rectum (Pavlica et al, 2003; Chang and Yeh, 1992). The normal urethra is visualized on sonography as a tubular structure with a thin, smooth echogenic wall, and the lumen distends to at least 4mm in diameter (Benson et al, 1991).

Penile Trauma:

Mechanism: Penile fracture is an uncommon injury caused by exertion by axial forces on the erect penis, resulting in a tear of he TA with extrusion of blood subcutaneously (Cummings et al, 1998). This injury usually occurs during vigorous sexual intercourse when the rigin penis slips out of he vagina and is misdirected against the partner's pubic bone or perineum resulting buckling trauma (Rosentein

and McAninch, 2004). Another common cause of penile fracture is self-inflicted abnormal downward bending of the erect penis to achieve detumescence due to patient's misinformation about penile tissues (Zargooshi, 2000). A blunt trauma to a flaccid penis usually does not lead to penile fracture and usually causes extratunical or cavernosal hematomas (Bertolotto and Mucelli, 2004). Penile injury secondary to a bite during sexual foreplay, resulting to a blunt crushing and disruption of the erect CC has also been reported (Hinev, 2002). Sonography can show an irregular hypoechoic or hyperechoic defects at the cavernosal rupture site. The use of penile rings or bands to increase potency and prolong erection can cause constrictive penile band injury.

Intracavernosal Hematomas Without Fractures: Injury to the subtunical venous plexus or to the smooth muscle trabeculae in the absence of complete tunical disruption can lead to cavernosal hematomas (Nora et al, 2001) Intracavernosal hematomas are usually bilateral and result from injury to the cavernosal tissue when the base of the penile shaft is crushed against the pelvic bones (Bertolotto and Mucelli, 2004). The sonographic appearance of a penile hematoma varies with the age of the lesion. Hematomas appear as hyperechoic or complex masses in the acute phase and then become cystic, often with septation (Chang and Yeh, 1992).

Urethral And Spongiosal Injury: This type of injury can result in urethral rupture but does not result in erectile dysfunction and about 20% of penile fractures are associated with lesions of the corpus spongiosum and urethra (Shweta et al, 2005). Inability to urinate, urethrorrhagia, and, in cases of late referral, extravasation of urine can be observed, although the absence of such findings does not exclude urethral damage (Forman et al, 1989). Evaluation of the urethra with sonography can help to identify interruption of the urethral wall, but urethrography may still be needed (EL-Bahnasawy and Gomba, 2000). Sonourethrography may be useful to show the continuity of the anterior urethra. Real-time examination of the urethra during intillation of jelly may increase the possibility of detecting extravasations through a ruptured urethal wall (Doubilet et al, 1991). The presence of air in the Cavernosal bodies in the absence of external penetrating trauma may be an indirect sign of urethral injury (Bertlotto and Mucelli, 2004). Sonography may be able to show edema or haematoma of the Corpus Spongiosum after penile trauma (Desser et al, 1999).

Lymphoma Of The Penis: Penile tumours, primary or metastatic, have been described as hypeochoic and usually heterogenous masses affecting mainly the Corpora Cavernosa (Nakayama et al, 1997; Dorak et al, 1992; Horenblas et al, 1994). When there is necrosis, hypoechoic nodular areas may be observed (Dorak et al, 1992; Pavlica and Barozzi, 1998). The appearance of Doppler Signal within the mass rules out hematoma and to suspect a tumour or an infection.

Penile lymphoma is an extremely rare neoplasm (Liu et al, 1999; Fairfax et al, 1995; Gonzalez-Campora et al, 1981). Secondary involvement of the Penis by lymphoma may be due to retrograde spread (hematic or lymphatic) or direct extension from neighbouring organs (Nakayama et al, 1997). Whether primary disease exists is controversial. Some authors suggst that clinically isolated lymphoma of the penis is only an initial manifestation of an occult nodal disease (Liu et al, 1999 and Fairfax et al, 19995). However, metastatic disease to the penis is rare; thus the lesion has been assumed to be primary in most reported cases (Lui et al, 1999) when no evidence of extrapenile illness has been discovered.

The appearance of penile lymphoma varies: it may appear as a mass, as plagues or ulcers in the skin of the organ, or as diffuse penile swelling (Laura et al, 2001). In most cases a focal lesion localized in the shaft of the penis (involving the Corpora Cavernosa) is seen, but the GP and prepuce may also be involved (Nakayama et al, 1997; Pow-sang and Orihuela, 1994; Gonzalez-Campora et al, 1981). Sonographically, it may appear as heterogenous,

hypoechoic well-delimited mass involving the Corpus Spongiosum.

Penile Leiomyosarcoma: Penile leiomyosarcoma is a relatively rare neoplasm of which only 27 cases have been reported in the world literature; most before the time that imaging modalities such as ultrasonography and magnetic resonance imaging (MRI) began to be used for characterization and staging (Pow-sang and Orihuela, 1994).

A list of malignant soft tissue neoplasm would include angiosarcome, Kaposis' sarcome, Fibrsarcoma, Malignant Fibrous Histiocytoma, Leiomyosacoma, and osteosarcoma (Rosai, 1996). Identification and evaluation of these lesions are potentially difficult, because they are difficult to characterized by visual appearance or palpation, and biopsy is more invasive than for superficial lesions (Nora et al, 2001). Imaging by ultrasound can help suggest the correct diagnosis and can also show subclinical lesions, which may affect management.

Penile leiomyosarcoma has been classified into superficial and deep types, with the latter having a tendency toward distant metastases and thus a poor prognosis (Nora et al, 2001). On ultrasonography, including color and power Doppler imaging, the diagnosis of sarcoma was suggested based on the presence of vascular, lobulated, hypoechoic and heterogenous mass. Satellite nodules in the proximal penile shaft highly suggest metastatic disease.

Conclusion

Sonographic examination should be performed for suspected penile injuries and masses as part of the initial diagnosis to characterize them and to evaluate the extent of involvement of the penis. Doppler examination is necessary as it enables the differentiation of a hematoma from a tumour as it assesses the activity of vascularised lesions. A good understanding of penile anatomy benefits the use of ultrasonography in its evaluation. In this review, we have presented the pertinent anatomy, the scanning technique, and some traumatic and pathologic entities, which illustrate the utility of ultrasonography in the diagnosis of penile diseases and disorders.

REFERENCES

Grawel A, Pai D, Ananthakrishnam N et al. (2000): Clinical and sonographic findings in carcinoma of the Penis. J. Clin. Ultrasound 28 (8): 399-406.

Benson C B, Boubilet P M, Vichers M A (1991): Sonography of the penis, Ultrasound Q 9:89-109.

Bertolotto M, Mucelli R P (2004): Non-penetrating Penile traumas: Sonographic and Doppler features: AJR Am J. Roentgenol 1 83: 1085-1089.

Bertolotto M, Neumaier C E (1999): Penile Sonography. Eur Radiol 9 (suppl 3) S 407-S412.

Chang S C, Yeh C H (1992): The application of dynamic transrectal ultrasound in the lower urinary tract of men and women. Ultrasound Q 10:185-223.

Cummings J M, Parora R O, Boullier J A (1998): Delayed repair of penile fracture. J. trauma 45: 153-154.

Desser TS, Ninomurcia M, Olcott E W et al. (1999): Advantages of performing sonourethrography with lidocaine hydrochloride jelly in a prepackaged delivery system. AJR Am J. Roengenol 173:39-40.

Dogra V, Bhatt S (2004): Erectile Dysfunction and priapism. In Dogra V, Reubens D(eds). Ultrasound secrets. First ed. Philadelphia, PA: Hanley and Belfus; 420-424.

Dorak AC, Ozkan GA, Tamac NI et al. (1992): Ultrasonography in the recognition of penile cancer. J. Clin. Ultrasound 20:624-626.

Doubilet PM, Benson CB, Silverman SG et al. (1991): The Penis. Semin Ultrasound CTMR 12: 157-175.

El-bahnasawy MS, Gomha MA (2000): Penile fractures: The successful outcome of immediate surgical intervention. Int. J. Impot Res 12:273-277.

Fairfax CA, Hammer CJ III, Dana BW et al. 1995): Primary penile lymphoma presenting as a penile ulcer. J Urol 153:1 1051-1052.

Forman HP, Rosenberg HK, Snyder HM III (1989): Fractured Penis: Sonographic aid to diagnosis. AJR Am J Roentgenol 153:1009-1010.

Gonzalez-Campora R, Nogales FF, Lerma E Jr, et al (1981): Lymphoma of the penis. J. Urol 126: 270-271.

Hinev A, I (2002): Re: Penile injury J Urol 167: 1802-1803.

Horenblas S, Kroger R, Gallee MPW, et al. (1994): Ultrasound in squamous cell cercinoma of the penis: a useful addition to clinical staging? Comparison of ultrasound with histopathology. Urology 43: 702- 707.

Laura BV, Xavier BC, Ramon VP, et al (2001): Lymphoma of the penis: Sonographic findings. J. ultrasound Med. 20:929-931.

Liu DW, Thorning DR, Krieger JN (1999): Primary Penile lymphoma: diagnostic difficulties and management options. Urology 54: 366.

Matteson JR, Nagler HM (2000): Intracavernous hematoma J. Urol 164: 1647-1648.

Nakayama F, Sheth S, Caskey CI, Hamper UM (1997): Penile metastasis from prostate cancer: Diagnosis with Sonography. J. Ultrasound Med. 16: 751-753.

Nora D, Harvey LN, Leon A et al (2001): Penile Leimyosarcoma: Sonographic and Magnetic resonance findings. J. Ultrasound Med. 20: 553-557.

Pavlica P, Barrozi L (1998): Ultrasound of Penile tumours and trauma Ultrasound Q 14: 95- 109.

Pavlice O, Barozzi L, Menchi I (2003): Imaging of Male urethra. Eur. Radio 13: 1583-1596.

Pow-sang MR, Orihuela E (1994): Leimyosarcoma of the penis. J. Urol 151: 1643-1645.

Rifkin MD (1984): Sonourethrography: technique for evaluation of prostate urethra. Radiology 153: 791-792.

Rosaid J (1996): Soft tissue. In Rosai J (ed). Ackerman's Surgical Pathology. Vol. 2 8th ed. St. Louis, MO: Mosby; 2021 - 2134.

Rosentein D, MCAninch JW (2004): Urologic emergencies. Med. Clin North Am 88: 494-518.

Sadeghi-Negad H, Dogra V, Seftel AD et al (2004): Priapism. Radio Clin North Am 42:427-443.

Schwartz AN, Wang KY, Mark LA et al (1989): Evaluation of normal erectile function with colour flow Doppler Sonography AJR Am Roentgenol 153: 1155-1160.

Shweta B, Ercan K, Deborah JR et al (2005): Sonographic evaluation of Penile trauma. J. Clin Ultrasound Med. 24: 993 - 1000.

Zargooshi J (2000): Penile Fracture in Kermanshah, Iran: report of 172 cases. J. Urol 164: 364-366.