The role of ultrasonography in the diagnosis and management of penile trauma

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Abstract

Purpose In this prospective study, we studied the role of ultrasonography (US) in the diagnosis and management of penile trauma.

Methods Between 2007 and 2014, 14 patients (mean age 39 years) with suspected penile fracture underwent US examinations. Almost all patients had a history of injury during sexual intercourse or manipulation of the penis. US examinations were performed in transversal and longitudinal planes starting at the level of the glans and moving down to the base of the penis. Color-Doppler was used to identify the vascular pattern or to see any abnormal vascularity.

Results The most common blunt injury to the penis that occurred in nine patients was penile fracture due to rupture of the corpus cavernosum. A tear occurred in only one of the corpora cavernosa. US showed an irregular hypoechoic or hyperechoic defect at the cavernosal rupture site. Four patients presented an injury to the subtunical venous plexus in the absence of complete tunical disruption. One patient had urethral rupture with inability to urinate and apparent urethrorrhagia. Ten patients underwent surgical operation, while four patients were observed and discharged after 2 days. Mean follow-up was 32 months (range 3–58). After 8 to 12 weeks, all of them were able to be sexually active as before. Angulations of penis persisted in one patient.

Conclusion US may be the preferred imaging technique for evaluation of penile fracture before surgery. It is easy to

perform, non-invasive, widely available, and inexpensive, although it requires an experienced team.

Keywords Penile trauma · Penile fracture · Ultrasonography · Color-Doppler sonography · Imaging · Tunica albuginea

Riassunto

Scopo In questo studio prospettico abbiamo analizzato il ruolo dell'imaging ecografico nella diagnosi e gestione del trauma penieno.

Metodi Tra il 2007 ed il 2014, 14 pazienti (età media: 39 anni) con sospetto di frattura del pene furono sottoposti ad uno studio ecografico. Quasi tutti i pazienti presentavano un riscontro anamnestico di traumi avvenuti durante un rapporto sessuale o manipolazione del pene. Gli esami ecografici furono eseguiti facendo scansioni su piani trasversali e longitudinali iniziando a livello del glande e procedendo sino alla base dell'asta. L'utilizzo del Color-Doppler è stato adoperato per visualizzare l'assetto vascolare o per identificare qualsiasi forma di anomalia vascolare.

Risultati La più comune forma di rottura traumatica del pene accorsa in 9 persone fu quella del corpo cavernoso. la rottura si verificò sempre a livello di un singolo corpo cavernoso. Lo studio ultrasonografico identificò il punto di rottura a livello del corpo cavernoso attraverso la visualizzazione di un irregolare stria ipoecogena o iperecogena. 4 pazienti presentarono una lesione del plesso venoso al di sotto della tunica albuginea senza rottura della stessa. Un solo paziente riportò un trauma dell'uretra presentando difficoltà alla minzione ed urethrorrhagia. 10 pazienti furono sottoposti ad intervento chirurgico, mentre gli altri 4 furono ricoverati in regime di osservazione e dimessi due giorni dopo. Il follow-up medio è stato di 32 mesi (range 3-58).

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Dopo circa 8-12 settimane tutti i pazienti ripresero la propria attività sessuale. In un solo paziente permase una deviazione permanente dell'asta.

Conclusioni Secondo la nostra opinione l'esame ecografico può essere considerato la tecnica d'imaging da preferire nella valutazione di una rottura peniena prima d'intraprendere un approccio chirurgico. E' semplice da eseguire, poco invasiva, ampiamente disponibile e poco costosa; anche se richiede operatori esperti.

Introduction

Penile trauma is an uncommon condition with an incidence of 1 in 175,000 hospital admissions [1]. Penile fracture (PF) is due to the rupture of the tunica albuginea and the corpus cavernosa. Usually, this happens in the setting of an erect penis during vigorous sex. Other causes include direct trauma, masturbation, falls, forceful manipulation, and rolling over in bed during an erection [2–4]. It presents as an emergency situation with indications for surgical repair. However, other cases of blunt penile injury without disruption of the tunica albuginea or urethral injury may be treated conservatively [5]. The patient's history and physical examination are sufficient to reach a provisional diagnosis of a penile fracture [6]. Ultrasonography (US) with high-resolution gray-scale imaging, and new high-frequency broadband traducers, alone or in combination with color and pulsed-wave Doppler form the basis for evaluation of penile trauma [7]. The aim of this prospective study was to represent US findings in 14 patients with acute penile trauma and its healing process.

Materials and methods

From August 2007 to December 2014, 14 patients with mean age 39 years (range 18–72 years) with suspected penile fracture underwent US examination in the emergency unit at our Department of Urology. Patients with erectile dysfunction (ED), any injury to the penis or any congenital lesion like hypo or epispadias were excluded from our study (two patients for severe ED preoperatively and one for congenital hypospadias). Almost all patients had a history of injury during sexual act (Fig. 1) except one, who had manipulated his organ for the purpose of masturbation with a vacuum cleaner during an erection. Investigations were performed with the patient in the supine decubitus with penis lying on the anterior abdominal wall using a General Electric Logiq 7 machine (GE Healthcare, Milwaukee, WI, USA) equipped with a 7–12 MHz multi-frequency linear probe. The examination

Fig. 1 A 54-year-old patient with penile fracture of the right corpus cavernosum. Clinical photograph showing a swollen penis with hematoma and deviation to the right side

was performed in transversal and longitudinal planes starting at the level of the glans and moving down to the base of the penis. Color-Doppler (CD) was used to identify the vascular pattern or to see any abnormal vascularity or malformations.

In normal conditions, the two corpora cavernosa are homogeneous in echo structure and identified as two hypoechoic circular structures [8]. The tunica albuginea is visualized as a linear hyperechoic structure covering the corpora cavernosa. The cavernosal artery is visualized on the medial portion of the corpora cavernosa [9, 10]. Most patients (71 %) underwent a surgical operation using various techniques. Mean follow-up was 32 months (range 3–58 months). This study was conducted by one urologist experienced in US.

Results

After penile trauma, all patients reported hearing a cracking or popping sound, along with a sharp pain, followed by rapid detumescence, swelling, ecchymosis, and deformity of the penis. One patient had abundant urethrorrhagia. The most common blunt injury to the penis in 64 % (9/14) of the patients was penile fracture due to rupture of the corpus cavernosum. A tear occurred in only one of the corpora cavernosa and its surrounding tunica albuginea; however, corpus spongiosum and urethral involvement did not occur. Fractures occurred in the proximal shaft (67 %, [6/9]) and midshaft (33 %, [3/9]) of the penis. Corpus cavernosal

Fig. 2 Longitudinal ultrasound image shows intra-cavernosal (cc) hematoma (h) and the site of ruptured tunica albuginea (marked by an arrow)

Fig. 4 Longitudinal ultrasound image shows an injury of the dorsal subtunical venous plexus in the absence of complete tunica disruption with hypoechoic hematoma (h)

Fig. 3 Longitudinal ultrasound image shows extra-cavernosal (cc) hematoma (h) and the site of ruptured tunica albuginea (marked by an arrow)

Fig. 5 Longitudinal ultrasound image shows an urethral rupture (u) and the complete tunica disruption with hematoma (h) outside the corpora cavernosa (cc)

ruptures were generally transversal (89 %, [8/9]) in the dorsal portion of the corpus cavernosum. In only one patient was the corpus cavernosal rupture in the ventral position adjacent to the urethra. US showed an irregular hypoechoic or hyperechoic defect at the cavernosal rupture site. The exact location of the tear has been demonstrated as an interruption of the thin echogenic line of the tunica albuginea and often showed an association of hematoma (Figs. 2, 3). CD sonography revealed some vascularity at the periphery of the lesions. In 28 % (4/14) of the patients an injury was presented to the subtunical venous plexus in the absence of complete tunical disruption with cavernosal hematomas. Hematomas appeared as hypo-anechoic in the acute phase (Fig. 4), then become hyperechoic, often with septation. CD sonography did not show any signals within the hematoma. The corpus spongiosum was intact, and arterial and venous structures appeared to have a normal flow. One patient had urethral rupture with inability to urinate and apparent urethrorrhagia (Fig. 5). The presence

of air in the cavernosal bodies in the absence of external penetrating trauma may be an indirect sign of urethral injury [11]. US showed hematoma in the corpus spongiosum. Ten patients underwent surgical operations, while four patients were admitted to the Urology Department for observation and discharged after 2 days. A urethral catheter was placed pre-operatively to identify and avoid the urethra. The hematoma was evacuated and the tear repaired with prolene 3/0. An artificial erection created with intra-cavernosal injection of normal saline revealed an intact repair with no leakages. The wound was closed with 3/0 vicryl. In all patients, US imaging findings were confirmed at surgery. Duration of hospital stay was between 2 and 4 days after surgery, and we advised the patients to abstain from sexual activity for 8 weeks. After 8–12 weeks, all of them were able to be sexually active as

Table 1 Ultrasonographic findings in 14 patients with penile trauma

Patient no	Perialbugineal hematoma	Subcutaneous hematoma	Tunica albuginea rupture	Surgical confirmation	Other tests	Recovery
1	Yes	Yes	Yes	Yes	No	Total
2	No	Yes	Yes	Yes	No	Total
3	Yes	Yes	No	Yes	No	Total
4	Yes	Yes	Yes	Yes	No	Angulation
5	Yes	Yes	Yes	Yes	No	Total
6	No	Yes	Yes	Yes	No	Total
7	Yes	Yes	No	Yes	No	Total
8	Yes	Yes	No	Yes	No	Total
9	No	Yes	Yes	Yes	No	Total
10	No	Yes	No	Yes	Yes	Total
11	Yes	Yes	Yes	Yes	No	Total
12	Yes	Yes	Yes	Yes	No	Total
13	Yes	Yes	Yes	Yes	No	Total
14	Yes	Yes	No	Yes	No	Total

before. The follow-up ranged from 3 to 58 months. Angulations of penis persisted in one patient (Table 1).

Discussion

Penile fracture is described as the rupture of the tunica albuginea and/or corpus spongiosum in the erect penis caused by rapid blunt force [12]. The tunica albuginea, which has a normal thickness of 2 mm when the penis is flaccid, is stretched during erection and its thickness is reduced to 0.25 mm. In most cases, curving or bending of the erect penis results from a transverse rupture of the corpus cavernosum [9]. Penile fracture generally occurs in the proximal or middle shaft and results in a transversal tear. Longitudinal tears are rare; none of our patients with acute penile fractures had longitudinal tears. The diagnosis of penile fracture is usually established based on its characteristic history and physical findings [13]. Patients report hearing a snapping sound during the sexual act, followed by immediate pain and penile detumescence, in addition to the emergence of large edemas, hematomas, and penile deformity [14]. However, additional diagnostic imaging modalities can be used for diagnosis. Radiologic evaluation has been described for patients with penile fractures, and these include retrograde urethrography, cavernosography, magnetic resonance imaging (MRI), US, and CD ultrasonography [15]. Retrograde urethrography and cavernosography are invasive, and prominent false-negative findings have been reported, while MRI is an excellent imaging modality with multiplanar capability and excellent tissue contrast [16, 17]. It can be useful as a diagnostic tool in the evaluation of patients with acute penile trauma, but it is expensive and not widely available everywhere [18].

Complications of penile fractures include corpora cavernosa fibrosis, with or without plaque formation, and rarely impotence due to impairment of veno-occlusive mechanism [9]. US is an ideal technique for evaluating patients with penile trauma and can be routinely used in an emergency. It is a non-invasive method that gives results faster than cavernosography and MRI [19]. Ideally, US of the penis is performed with a high-frequency (7–12.0 MHz) linear transducer, anatomic orientation, and ample gel to provide high-quality images [1, 4]. The three corporal bodies are well demarcated at US. The corpus spongiosum is mildly hypoechoic compared with the corpora cavernosa, which have homogeneous mixed echogenicity, due to the complex of their vascular sinuoids. In US, tunica albuginea is easily represented as a hyperechoic linear line. It can show the integrity of the tunica albuginea as well as the extent and location of a tunical tear or to see any hematoma on either side of the tunica. On US, a heterogeneous ill-defined image appears predominantly hypoechoic or hyperechoic, depending on the time of injury. US shows the position of the hematoma within the corpus cavernosum, septal area, or sometimes outside the tunica albuginea [8]. Injury to the subtunical venous plexus, or the smooth muscle trabeculae in the absence of complete tunica disruption, can lead to cavernosal hematomas [3]. However, a discontinuity of the echogenic line representing albuginea tear is important, as surgery is usually needed [17]. Associated vascular injuries can be shown by CD techniques [20]. If an arterial lesion is present, a post-traumatic arteriovenous fistula with increased venous pressures and dilatations of the injured vessel may result [20, 21]. In literature, studies on the diagnosis of penile fracture through CD ultrasonography, reported as a valuable diagnostic tool, are limited in

number [21]. The ultrasound findings were described for penile trauma by many authors, but we found that US was useful to plan a fast surgical management or to ask for other radiological imaging for further evaluation [22]. However, this technique is operator-dependent, and the major obstacle is a lack of tissue contrast. Other limitations of the US are that edematous swelling of the penis and clots within the tear deteriorate the image contrast and can hide the defect [19].

In our opinion, an immediate surgical intervention has been associated with a reduced risk of permanent penile curvature, shorter duration of hospital stay, and decreased return time to normal erectile function [23]. Our US findings and surgical outcomes were similar. In this study, the patients had penile US performed about an hour after presentation to the emergency unit. One patient additionally had a retrograde urethrography, which confirmed urethral injury. In literature, urethral injuries are present in approximately 20 % of patients with penile fractures [24]. This diagnosis should be entertained if the patient complains of difficulty voiding, hematuria or urethrorrhagia. However, the role of US is less clear in these patients. The following are the US findings suggestive of urethral injuries: a discontinuous penile urethra, air in the cavernosal bodies, and edema or hematoma of the corpus spongiosum, although retrograde urethrography will likely be required to confirm or exclude the diagnosis, as in our case [10, 24]. However, most of our patients had surgery 3 h after presentation in the emergency unit, incurring no delay in surgery due to the prompt US investigations performed.

Conclusion

Penile fractures can be properly diagnosed and treated to achieve the best outcomes in terms of healing and quality of life post-operatively. US may be the preferred imaging technique for evaluation of penile trauma before surgery, because its improved spatial resolution permits evaluation of normal and pathologic anatomic structures generally smaller than 1 mm [3], and increased CD sensitivity to low flow permits full evaluation of penile vascularity [19]. It is easy to perform, non-invasive, widely available, and inexpensive. However, this technique is operator-dependent and requires an experienced team.

Compliance with ethical standards

Conflict of interest Lucio Dell'Atti declares that he has no conflict of interest.

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki

Declaration of 1975, as revised in 2000 (5). All patients provided written informed consent to enrolment in the study and to the inclusion in this article of information that could potentially lead to their identification.

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