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LETTER TO THE EDITOR

Erection Function

New views on ultrasonography in high-flow priapism, with typical cases

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Dear Editor,

Priapism is an uncommon pathological erection that mainly occurs in adult males between the ages of 20 years and 50 years.[1] It is defined as an involuntary erection that persists more than 4 h without any sexual stimulation.[2] This article reports two patients with high-flow priapism, which is relatively rare. We propose some new ultrasound features to diagnose this disease. After embolization, we assessed the embolization location and monitored whether there was recanalization in the embolization treatment site following therapy through ultrasonography. These have not been mentioned in the previous literature.

Both patients visited the First Affiliated Hospital of Dalian Medical University (Dalian, China) with a painless semirigid erection. One was patient A, 21 years old, who had a straddle injury and erection time of 3 days. The other was patient B, 54 years old, who had no obvious predisposing causes and an erection time of 15 days. Physical examination showed a normal perineum in both cases and nontender penises of normal color without a palpable mass or effusion. The clinical histories were negative for dysuria. The cavernous blood gas analyses were as follows: patient A, pH7.5; oxygen partial pressure (pO_2): 86 mmHg; and partial pressure of carbon dioxide (pCO_2): 36 mmHg; and patient B, pH7.4; pO_2: 92 mmHg; and pCO_2: 34 mmHg (1 mmHg = 0.133 kPa). These results showed that the blood was bright red and close to the properties of arterial blood.

Subsequently, both patients underwent imaging examinations (the imaging data of patient B appears in **Supplementary Figure 1**). Penile sonography was performed using a high-frequency linear probe (MyLab Twice ultrasonic instrument, Esaote, Genoa, Italy) with frequencies from 7 MHz to 10 MHz. Grayscale ultrasound showed that the echotexture of the corpora cavernosa and urethral cavernosa was homogeneous. The tunica albuginea was smooth and tidy, without continuous interruption. An ultrasound scan of the crura of the penis showed an irregular hypoechoic area surrounded by echogenic tissue. The hypoechoic area had well-circumscribed margins, and within these margins, pulsation and tiny hypoechoic floating particles were visible. After careful observation, we found that the hypoechoic area was connected to the cavernous artery, forming a cavernous arteriovenous fistula (**Figure 1a**). Color Doppler ultrasonography (CDU) showed that in the irregular hypoechoic area of the crura of the penis, there was a full-color flow spectrum (**Figure 1b**). We found that the cavernosal artery feeding the fistula area had a high velocity and turbulent flow spectrum. The extravasation of blood from the lacerated cavernosal artery extended into the cavernous sinusoidal space, which caused the blood flow in the cavernous body to increase significantly.

Both patients underwent computed tomography angiography (CTA) and digital subtraction angiography (DSA), which depicted the extravasation of contrast at the sites of arteriovenous fistulae (**Figure 1c** and **1d**). Our research was granted ethical approval by the Ethics Committee of The First Affiliated Hospital of Dalian Medical University, Dalian, China (No. YJ-KY-FB-2021-06). Written informed consent was obtained from the patients. The patient data were anonymized. Subsequently, these patients were treated by superselective microcoil embolization. After the procedure, there was no extravasation of contrast following effective embolization (**Figure 1e**). Both patients were followed up for 1 year. In patient B, the penis gradually returned to a normal state by the 1-month follow-up, allowing the resumption of a normal sexual life. After ejaculation, the penis was weak, and the patient had morning erections. However, patient A still felt that the penis was hard, impairing his sexual life at the one- and three-month follow-ups. The symptoms improved at the 6-month and 1-year follow-ups, helping him resume a satisfactory sexual life.

High-flow priapism is characterized by a persistent, painless semirigid erection with no obvious clinical symptoms.[3] Generally, patients will not go to the hospital at the outset and will choose to observe their symptoms for a few days or even longer, and high-flow priapism is easily misdiagnosed. Moreover, it is difficult for high-flow priapism to heal by itself due to the continuous perfusion of the corpora cavernosa with high-flow arterial blood. There is increasing clinical evidence that long-standing perfusion with high-flow arterial blood could eventually lead to cavernosal fibrosis and erectile dysfunction (ED).[4,5] Thus, clear diagnosis is important.

Currently, the treatments for high-flow priapism mainly include conservative treatment, surgery, and superselective embolization. Surgical treatment is usually associated with significant injuries, which raises the risk of ED. A study indicating that the incidence of ED reaches 50% after arterial ligation injuries caused by surgery is reported in the literature.[6] Superselective embolization causes less trauma and fewer complications and is the primary treatment of choice. Common occlusive agents include gelfoam, autologous clots, and microcoils. The recanalization rates of gelfoam and autologous clots

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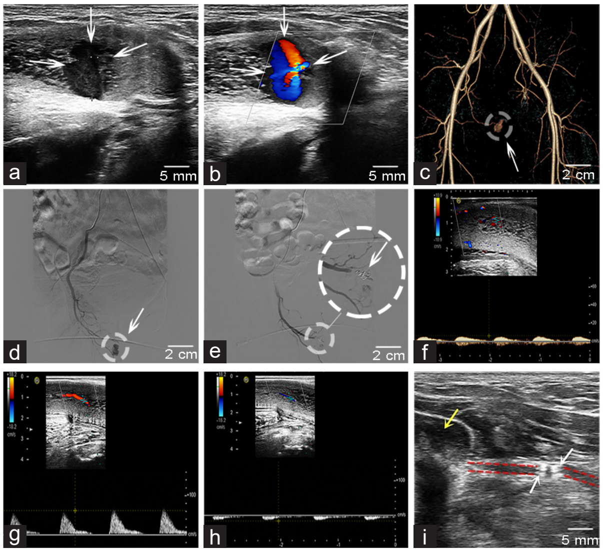

Figure 1: (**a**) Grayscale ultrasound image of the crura of the penis in the longitudinal section. The irregular hypoechoic area shown by the white arrow is an arteriovenous fistula, and pulsation and tiny hypoechoic floating particles are visible within this fistula. (**b**) CDU showing a full-color flow spectrum in the irregular hypoechoic area. (**c**) CTA and (**d**) DSA showing the extravasation of contrast at the sites of the arteriovenous fistulae (arrow). (**e**) After embolization with a microcoil (arrow), there was no extravasation of contrast following the fistulae. (**f**) CDU image of the blood-flow spectrum in the cavernous sinusoidal space in the longitudinal section of the middle of the penis. As shown in the figure, a typical arterial spectrum and arterial pulsation were found in the expanded cavernous sinusoidal space. This is a specific manifestation in high-flow priapism. (**g**) Ultrasonic spectrum of the cavernous artery on the healthy side, in the longitudinal section of the penis, is a red high-speed blood flow signal, which is the same as that in a healthy person. However, (**h**) the ultrasonic spectrum of the cavernous artery on the affected side in the longitudinal section of the penis shows a blue blood flow signal with low velocity and a reversed direction. The blood flow direction was opposite to that of the healthy side. (**i**) Grayscale ultrasound image of the perineal area in patient A. White arrows: the strong echo of the microcoil for embolization. Red dotted line: distal internal pudendal artery near the cavernous body. Yellow arrow: cavernous body. CDU: color Doppler ultrasonography; CTA: computed tomography angiography; DSA: digital subtraction angiography.

are high, so they are used as temporary occlusive agents.[7] In contrast, microcoils have a low recanalization rate, so they have been widely used as permanent occlusive agents.[8]

In these two cases, in addition to the typical ultrasound features that have been reported in the previous literature, we found another ultrasound feature that has not been reported before and was more conducive to the diagnosis: the blood flow in the cavernous body was significantly increased, and a typical arterial spectrum was found in the cavernous sinusoidal space (**Figure 1f**). The normal cavernous sinusoidal space should have an obvious venous spectrum. This feature is more in accordance with the hemodynamic characteristics of high-flow priapism, and its specificity is higher, so it is recommended as the primary examination criterion.

There was an interesting phenomenon in patient B: blood flow was not seen in the area of microcoil embolization in the embolized internal pudendal artery. However, blood flow signals were seen in the distal artery of the embolization area. We found that the vascular supply of this distal affected artery was fed by a healthy contralateral artery through the communicating arteries, leading to the two arteries flowing in opposite directions (**Figure 1g** and **1h**). This phenomenon has been strongly associated with the prognosis of patients. More cases are needed to verify this view.

We also found other features that have not been reported in the previous literature; for example, the diameter of the cavernosal artery on the healthy side was greater than that on the affected side, and the resistive index (RI) of the cavernosal artery was significantly different between these high-flow priapism patients and healthy adults. However, due to the small number of cases, the above features need to be studied further. Some scholars believe that the peak systolic velocity and end-diastolic velocity of the cavernosal artery are reliable predictive factors for priapism.[9,10] We disagree with this view, because the velocity measurements are greatly affected by the blood pressure, degree of erection, extent of arteriovenous fistula, chosen ultrasonic parameters, and angle of the spectrum Doppler measurement. Therefore, velocity measurement should be only one reference factor.

In addition, we placed the high-frequency probe in the perineum area and accurately found the microcoil for embolization in the internal pudendal artery (**Figure 1i**). Then, we used CDU to assess embolization location and monitored for recanalization following therapy. In patient A, at the one- and three-month follow-ups, punctate blood flow signals were still detected around the microcoil embolization. This corresponds to the clinical symptoms of the patient during follow-up, indicating that this method is effective for diagnosis, as it is a noninvasive assessment that hopefully can prevent patients from undergoing an invasive secondary contrast examination.

AUTHOR CONTRIBUTIONS

WLX and TJ conceived the idea of the study. WLX collected the clinical information and drafted the manuscript. TJ provided the academic guidance and helped to draft the manuscript. YC helped collect the imaging data. KNW and YL revised the manuscript and participated in discussion. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declared no competing interests.

Supplementary Information is linked to the online version of the paper on the *Asian Journal of Andrology* website.

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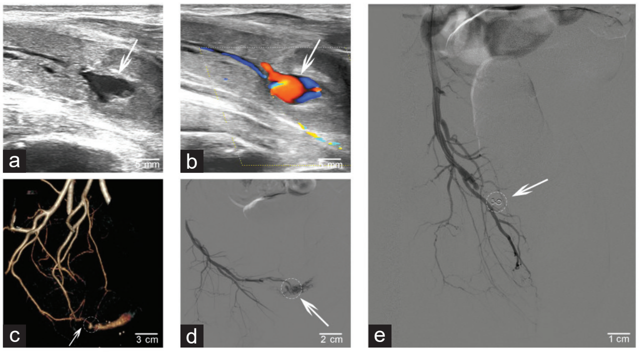

Supplementary Figure 1: This figure shows the imaging examination of patient B. (**a**) Grayscale ultrasound image of the crura of the penis in the longitudinal section. The irregular hypoechoic area shown by the white arrow is an arteriovenous fistula, and visible pulsation and tiny hypoechoic floating particles are visible within this fistula. (**b**) CDU showing that in the irregular hypoechoic area, there is a full-color flow spectrum. (**c**) CTA and (**d**) DSA showing the extravasation of contrast at the sites of arteriovenous fistulae (arrow). (**e**) After embolization with a microcoil (arrow), there was no extravasation of contrast following the fistulae. CDU: color Doppler ultrasonography; CTA: computed tomography angiography; DSA: digital subtraction angiography.