Vas deferens sonographic appearances of tuberculosis lesions of 19 cases of male genital systemic tuberculosis

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Abstract
To investigate the sonographic findings of the vas deferens in male genital tuberculosis.

The ultrasonographic findings of the vas deferens of 19 cases of genital tuberculosis were retrospectively analyzed.

According to the pathological and ultrasound findings, the ultrasonographic appearances of the vas deferens tuberculosis could be divided into 4 groups, 1 of normal sonograms, 3 of abnormal sonograms. The abnormal ultrasonographic appearances of the vas deferens tuberculosis were considered 3 categories as follows: diffusely thickening of vas deferens, nodular thickening of vas deferens, and space-occupying lesions adjacent to the vas deferens.

The ultrasound manifestations of vas deferens in tuberculosis of the male genital system have certain characteristics. Combination of clinical manifestations, history of tuberculosis, experimental antituberculosis treatment, and ultrasound examination of vas deferens can suggest tuberculosis of vas deferens. Furthermore, it can provide objective basis for the comprehensive and noninvasive evaluation of the impact of genital tuberculosis on the reproductive ability for further treatments.

Abbreviations: CDFI = color doppler flow imaging, ED = ejaculatory duct, SV = seminal vesicle, TB = tuberculosis, TRUS = transrectal ultrasound, US = ultrasound, VD = vas deferens.

Keywords: abnormality, diagnosis, sonographic appearance, ultrasound, urinary and genital systemic tuberculosis, vas deferens

1. Introduction
The vas deferens (VD) originates from the tail of epididymis. It is composed of a mucous membrane, muscular layer, and fibrous membrane. The tube wall is thick and the lumen is small. The inner diameter is about 0.3 mm, while the outer diameter is 1.7 to 2.4 mm. Tuberculosis (TB) of the VD is a rare disease that is often secondary to urogenital TB and can lead to obstruction of the VD, thereby causing infertility in males. The ultrasound (US) can show the testes VD, spermatic VD, groin VD, while transrectal ultrasound (TRUS) can display pelvic VD, especially the ampulla of VD and the segment of VD close to the seminal vesicle (SV).

According to the state of art publication on normative male genital tract US characteristics,[1] the whole male genital system can be revealed clearly. The diameter and the volume of testis, epididymis, SV, VD, and prostate can be measured. US is of great value in the male urinary and reproductive system due to the widespread utility of TRUS. Various congenital and acquired vas deferential lesions have been detected and diagnosed, such as congenital bilateral or unilateral absence of VD, VD injury, deferentitis, and so on.

TB of the male genital tract has a considerable impact on fertility and remains a medical challenge.[2] Ultrasonography is the best imaging modality for the diagnosis of the diseases of male genital tract. US plays an important role in the diagnosis and treatment of TB of prostate, SV, epididymis, and testicle,[3–5] but the ultrasonic manifestations of TB in the VD are rarely reported.[6–7] Further observational study is needed to elucidate the ultrasonic changes of VD in patients with genital systemic TB.

Hence, a retrospective analysis of the clinical and US data of 19 cases of TB of the male genital system was conducted in our hospital to reveal the pathological changes of VD in order to systematically and comprehensively assess the disease and provide objective basis for clinical treatment selection.

2. Materials and methods
This retrospective study was conducted in accordance with the Declaration of Helsinki, and with approval from the Ethics Committee of Sichuan University (Chengdu, China). A total of 19 patients hospitalized into West China Hospital, Sichuan University between June 2009 and April 2016, diagnosed as male urinary or genital system TB were included. Seven cases were operated. The operation methods included epididymal resection, epididymal orchietomy, and epididymal spermatic
According to the pathological and ultrasonic findings, the ultrasonographic appearances of the VD TB could be divided into 4 groups, 1 of normal sonogram, 3 of abnormal sonograms. The ultrasonographic appearances of the VD TB were considered 4 categories as follows: nodular thickening of VD in 4 cases (category 1), diffuse thickening of VD in 11 cases (category 2), space-occupying lesions adjacent to VD in 3 cases (category 3), and normal ultrasonographic appearance in 1 case (category 4), as shown in Table 1 and Figures 1–4.

In the 4 cases with nodular thickening of VD (category 1), solitary nodule was found in 3 cases and multiple nodules were found in 1 case. The echogenicity of the nodules of VD were complicated. The diameter of the nodules was 3 to 8 mm, the boundaries were clear, the internal blood flow signals were poor, calcification was found in 2 cases, and irregular lumen stenosis was found in 1 case.

In the 11 patients with diffusely thickened VD (category 2), sonography showed widening of the outer diameter (about 1.7–9.0 mm) and inner diameter of VD (about 0.2–2.0 mm) of the VD, wall thickness enlargements of VD (about 1.0–2.5 mm) and heterogeneous tube echo. In 2 of the 11 cases, anechoic area was found in the VD. No obvious blood flow signals were found in VD in 9 cases, and internal linear blood flow signals were found in 2 cases. The VD intrascrotal segment thickening was observed in 9 cases. Whole thickening of the total segments was discovered in 2 cases, of which 1 was bilateral and the other 1 was unilateral.

In the 3 patients who had space-occupying lesions adjacent to the VD (category 3), sonography showed hypoechogetic masses of about 11 × 7 × 8 mm, 22 × 12 × 17 mm, 49 × 33 × 40 mm, respectively, with clear boundary, regular shape, and flowing internal echoes. Internal spot-shaped blood flow signal was seen in 1 case, peripheral linear blood flow signal was seen in 1 case, and no obvious blood flow signal within and around was seen in 1 case.

Normal ultrasonographic appearance of VD was seen in 1 case.

Male genital US characteristics of the whole genital system were investigated (Table 2, Fig. 5). Clinical features, andrological characteristics, fertility status, and semen characteristics of the 19 cases of male genital TB were summarized in Table 3.

4. Discussion

4.1. VD abnormal ultrasonographic appearance in TB of male urinary and genital system

Among cases of male reproductive system TB, epididymal TB is most commonly found in the clinic, while prostate TB is most frequently found in autopsy. Among cases of male reproductive system TB, epididymal TB is most commonly found in the clinic, while prostate TB is most frequently found in autopsy. The VD are located between the prostate and epididymis, so both types of TB can involve the VD. The main pathological changes of the VD TB are tubercular and caseous necrosis, VD thickening, resembling cord-like or string of...
beads. The caseous necrosis of the VD subsequently penetrates through the wall of the VD and forms a tuberculous cold abscess near the broken VD. When the lesion of the VD TB is mild, there is no obvious abnormality visible by naked eyes. Eleven cases in the category 2 sonographically showed thickening of VD, heterogeneous hypoechoic, representing edema and proliferation of VD lesions. Four cases in the category 1 sonographically showed nodular thickening of the VD, heterogeneous internal echoes, representing the VD proliferation and necrosis, fibrosis, and calcification with liquefaction. Three cases in the category 3 sonographically showed masses adjacent to the VD, representing disappearance of the normal structure of VD, invasion of the outer membrane of VD by the lesion, and localized abscess formation in the VD side. One case was only diagnosed by pathology. High-frequency ultrasonography can display different types of blood supply of abnormal VD. Ultrasoundography is the best imaging modality for the diagnosis of the diseases of male genital tract. Yang et al reported that the sonographic findings for tuberculous vasitis were heterogeneously hypoechoic with no blood flow in all 3 cases. Transrectal sonography is a useful modality to evaluate seminal duct abnormalities. The SVs and the VD can also be affected by TB, and cross-sectional images show wall thickening, contraction, or intraluminal or wall calcifications. With the improvement of resolution of ultrasonic diagnostic equipment, all parts of the seminal canal can be optimally displayed on US, which makes ultrasonic diagnosis of VD disease a new choice. Inhomogeneity, hypoechoic or hyperechoic pattern, coarse epididymal calcifications, or epididymal hyperemia, which are considered typical CDUS features of chronic epididymitis. Beyond that, an increased size (>6 mm) of the epididymal tail, inhomogeneous epididymal tail, and hyperechoic epididymal pattern are considered by some authors as CDUS features suggestive of male accessory gland infections. Testis inhomogeneity and hypoechoogenicity at ultrasonography are suggestive of atrophy and fibrosis and considered important signs of a reduced testicular function and overall impairment of spermatogenesis. SV hyperechogenicity is a parameter indicative of fibrosis of the glands, the end stage of an inflammatory process. Furthermore, thickening and calcification of the SV glandular epithelium are considered by some authors as US features suggestive of MAGI. A higher prevalence of prostate moderate-severe nonhomogeneity, hypoechoic texture, and hyperemia were observed in prostatitis-like symptoms males of infertile couples. There are very few reports of scrotal US for the diagnosis of TB of the VD or only VD TB was reported as part of ultrasonography for the diagnosis of male urinary and genital tract TB. In this study, the VD ultrasonographic manifestations of 19 male genital TB patients were examined through scrotum and rectum. Since the VD could only be partially removed for pathological examination, it was not possible for all abnormal VD in US to be directly confirmed by pathological examination of VD specimens.

4.2. Ultrasonic diagnosis and differential diagnosis of VD TB

The diagnosis of TB of VD cannot clarify without the history of TB of other organs. In this study, 19 cases of TB of male urinary
Figure 2. VD tuberculosis ultrasound findings (category 1, nodular thickening) and pathology results. (A) White arrow shows that the right VD was segmentally thickened in scrotum. (B) The granuloma (white arrow) and caseous necrosis (black arrow) was found at the peripheral region of the VD in the picture of HE staining (×40) after the vasectomy. (C) In the acid-fast staining picture, the coral-red positive bacillus was visualized (black arrow). (D) The 2 lines represent the amplification of the tuberculosis DNA fragments in the positive control group and the case group which was indicated by the white arrow and black arrow in the qPCR test, respectively. VD = vas deferens.

Figure 3. VD tuberculosis ultrasound findings (category 2 diffusely thickening VD) and pathological results. (A) The thickened wall and dilated lumen were indicated in the groin segment of the left VD in a 58-year-old man by the white arrow. (B) The right VD pelvic segment of the patient. Thickened VD wall was indicated by the white arrow, inside which the dilated lumen was revealed. (C) The thickened wall and dilated lumen was also indicated in the groin segment of the right VD by the white arrow. The CDFI picture shows abundant blood signals. (D) In the HE staining (×200) slides, the black arrow indicates the wall of the VD, white arrow indicates the granuloma. (E) In the acid-fast staining slide, black arrow indicates the coral-red positive bacillus. (F) The 2 lines represent the amplification of the tuberculosis DNA fragments in the positive control group and the case group which was indicated by the white arrow and black arrow in the qPCR test, respectively. CDFI = color Doppler flow imaging, VD = vas deferens.
and genital system were accompanied by TB of other organs, and there was no case of simple TB of the VD. The US examination of the male reproductive system is crucial, especially the US imaging of each segment of VD. For ideal results, both scrotal US and TRUS are needed. The sonographic characteristics of testicular TB, epididymal TB are helpful for the ultrasonographic diagnosis of the VD TB. Drudi et al.\(^\text{[17]}\) and Türkvatan et al.\(^\text{[18]}\) described multiple small hypoechoic nodules in the enlarged testis as the miliary type and suggested that this sonographic pattern was a feature of TB orchitis. Kim et al suggested that an enlarged heterogeneous epididymis can differentiate TB from non-TB epididymitis.\(^\text{[17]}\) A heterogeneously hypoechoic pattern of epididymal enlargement, bilateral epididymal involvement, and concomitant testicular lesion strongly suggest TB, especially in patients with evidence of TB elsewhere in the body and failure of conventional antibiotic therapy.\(^\text{[17]}\) The disease usually starts in the caudal portion of epididymis, perhaps due to its richer blood supply as compared to other parts of the epididymis, or because it is the first portion involved by urinary reflux along the VD.\(^\text{[20]}\) Therefore, TB of the VD is often accompanied by epididymal TB. Yang reported that the sonographic findings for tuberculous vasitis were heterogeneously hypoechoic in all the examined cases. On color Doppler sonography, no blood flow was identified within the lesions of the VD.\(^\text{[17]}\) There were 11 cases of heterogeneous hypoechoic signals in the VD, accounting for 57.90% (11/19), and 3 cases of internal blood flow signal, accounting for 15.79% (3/19).

| Table 2 | Ultrasound data about the male genital system of the 19 patients with tuberculosis. |
|---------|-----------------------------------------------------------------------------------|
| **Prostate** |  |
| Prostate mean volume, mL | \(17.6 \pm 4.12\) |
| Prostate calcifications (n, %) | 14, 73.7 |
| Inhomogeneous prostatic texture (n, %) | 9, 47.4 |
| Hypoechoic prostatic texture (n, %) | 3, 15.8 |
| Prostatic hyperaemia (n, %) | 8, 42.1 |
| **Seminal vesicles** |  |
| Mean anteroposterior diameter, mm | \(9.90 \pm 2.68\) |
| Hyper-echoic seminal vesicles (n, %) | 7, 36.8 |
| Unilateral (n, %) | 5, 26.3 |
| Bilateral (n, %) | 2, 10.5 |
| **Ejaculatory ducts** |  |
| Dilated ejaculatory duct (n, %) | 6, 31.6 |
| Unilateral (n, %) | 5, 26.3 |
| Bilateral (n, %) | 1, 5.3 |
| **Testis** |  |
| Mean testis volume, mL | \(13.31 \pm 5.88\) |
| Varicocele (n, %) | 2, 10.5 |
| Unilateral (n, %) | 2, 10.5 |
| Bilateral (n, %) | 0, 0 |
| **Epididymis** |  |
| Mean size of the head, mm | \(8.38 \pm 2.39\) |
| Mean size of the tail, mm | \(8.38 \pm 4.57\) |
| Heterogeneous epididymis (n, %) | 12, 63.2 |
| Unilateral (n, %) | 7, 36.8 |
| Bilateral (n, %) | 5, 26.3 |
| Hypoechoic epididymis (n, %) | 12, 63.2 |
| Unilateral (n, %) | 7, 36.8 |
| Bilateral (n, %) | 5, 26.3 |
| Hyperemic epididymis (n, %) | 3, 15.9 |
| Unilateral (n, %) | 2, 10.5 |
| Bilateral (n, %) | 1, 5.3 |
| Coarse epididymal calcifications (n, %) | 12, 63.2 |
| Unilateral (n, %) | 8, 42.1 |
| Bilateral (n, %) | 4, 21.1 |
| Hyperaemia epididymis (n, %) | 4, 21.1 |
| Unilateral (n, %) | 2, 10.5 |
| Bilateral (n, %) | 2, 10.5 |
| Increased (6 mm) epididymal tail (n, %) | 12, 63.2 |
| Unilateral (n, %) | 4, 21.1 |
| Bilateral (n, %) | 8, 42.2 |
| **Vas deferens** |  |
| Mean diameter of the vas deferens, mm | \(2.43 \pm 1.03\) |
| Deferential ampulla calcifications (n, %) | 1, 5.3 |
| **Obstruction of the seminal tract** |  |
| Obstruction among epididymis tail and vas deferens Unilateral (n, %) | 13, 68.4 |
| Bilateral (n, %) | 3, 15.9 |
| **Ejaculatory duct obstruction** |  |
| Unilateral (n, %) | 5, 26.3 |
| Bilateral (n, %) | 2, 10.5 |
| **Inguinal obstruction** |  |
| Unilateral (n, %) | 1, 5.3 |
| Bilateral (n, %) | 0, 0 |

Data are expressed as mean±SD and as percentages when categorical.
Anatomic obstruction by granulomas or distortion of the normal anatomy by fibrosis surrounding the reproductive tract is the commonest cause of infertility.\(^{[21]}\) All attempts must be made for early diagnosis and treatment of this condition to avoid unnecessary epididymectomy and adverse effect on fertility.\(^{[19]}\) Local symptoms are usually insidious and progressive. Systemic manifestations such as fever, chills, and sweat are rare in isolated genital TB. Tuberculous genital infection can be confused with other bacterial (including nontuberculous mycobacterial) infections, fungal disease, tumors, and cysts as well as with numerous uncommon illnesses.\(^{[22]}\) Some clinical findings, gray-scale sonography, and color Doppler sonography were useful in differentiating tuberculous epididymal abscess from pyogenic epididymal abscess. The presence of long-term scrotal swelling without tenderness and a lower degree of blood flow in the peripheral portion of a large abscess are suggestive of tuberculous epididymal abscess.\(^{[23]}\) But in our study, the appearance of CDFI of the space-occupying lesions adjacent to VD varied in 3 cases. The manifestation was including internal spot-shaped blood flow signal, peripheral linear blood flow signal, and no obvious blood flow signal within and around, respectively. That may suggest different treatments. Furthermore, spermatic granulomas often require identification with the VD TB. However, sperm granuloma in VD is more common after vasectomy or trauma. There was no history of vasectomy or trauma in 19 cases. Calcification of the VD and SVs has been described in association with genitourinary TB, diabetes, and hyperparathyroidism, amongst other conditions.\(^{[24,25]}\) For genitourinary TB, the fertility outcome is crucial. Sperm retrieval and cryopreservation should be considered for potential intracytoplasmic sperm injection.\(^{[26]}\)

### Table 3

| Clinical features                  | 4, 21.1 | 0, 0 | 5, 26.3 | 10, 52.6 |
|-----------------------------------|---------|------|---------|----------|
| Chronic pelvic pain (n, %)        |         |      |         |          |
| Hemospermia (n, %)                |         |      |         |          |
| Pulmonary tuberculosis (n, %)     |         |      |         |          |
| Epididymal mass (n, %)            |         |      |         |          |
| Andrological characteristics      |         |      |         |          |
| Cryptorchidism (n, %)             |         |      |         |          |
| Varicocele (n, %)                 |         |      |         |          |
| Prader testicular volume decrease (n, %) | | | | |
| Scrotal spermatic cord pain (n, %) |         |      |         |          |
| Spermatic cord hardening (n, %)   |         |      |         |          |
| Testicular induration (n, %)      |         |      |         |          |
| Fertility status                  |         |      |         |          |
| Primary infertility (n, %)        |         |      |         |          |
| Secondary infertility (n, %)      |         |      |         |          |
| Semen characteristics             |         |      |         |          |
| Azooospermia (n, %)               | 1, 5.3  |      |         |          |
| Asthenospermia (n, %)             | 5, 26.3 |      |         |          |
4.3. Relationship between ultrasonographic abnormal manifestations of VD and reproductive system and treatment options in TB of the genital system

TB of the male genital system should be systematically and comprehensively assessed. Prostate and SV TB are generally conservatively treated.

TB of VD and epididymis with substantial echo, without abscess formation or invasion of surrounding tissues should be conservatively treated. The rich blood supply in lesion or intratunical rifampicin injection has a good curative effect.[27] TB of VD and epididymis with mixed echo, abscesses, sinus formation or invasion of surrounding tissues or testicles should be surgically treated, and preoperative and postoperative anti-TB treatment should be given. In this study of 19 surgical cases, preoperative or postoperative anti-TB treatment led to reduction of the VD lesions in 12 cases. The transrectal and trans-scrotal US should be reviewed at 2 to 3 months after anti-TB treatment.[28]

The treatment plan should be adjusted according to the results of the US examination.

5. Conclusions

In summary, TRUS and scrotal US are inexpensive, noninvasive and available in most urology and andrology departments. This study indicated that US manifestations of VD in tuberculosis of the male genital and urinary system have certain characteristics. Combination of clinical manifestations, history of TB, experimental anti-TB treatment, and US examination of VD can suggest TB of VD.

6. Limitations

This study had some limitations. It was subject to recall bias owing to its retrospective nature. The number of cases was relatively small, with only 7 surgery cases, and early cases were few.

Author contributions

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