

Transvaginal ultrasonography of nongynecologic pelvic lesions*

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Abstract

Transvaginal ultrasonography (TVUS) is one of the preferred imaging modalities in patients with gynecologic problems because of its high diagnostic accuracy, noninvasiveness, and wide availability. In endovaginal scanning, the problem of sonic attenuation is much less significant than with the transabdominal approach in the evaluation of the viscera in the true pelvis. Placement of high-frequency, high-resolution probes within the vagina allows accurate assessment of all anatomic structures of the female reproductive tract within the pelvis, and, incidentally, a variety of pathologic conditions affecting the intestinal tract, the urinary system, the pelvic walls, vessels, lymph nodes, and peritoneum can be assessed by this technique. In this article, we show the appearances of nongynecologic lesions of the female pelvis as imaged with TVUS and discuss the clinical indications to this kind of study and the role of TVUS in guiding interventional maneuvers through the vaginal vault. All endovaginal scans were taken with transducers at frequencies of 5.0–7.5 MHz.

Key words: Transvaginal ultrasonography—Magnetic resonance—Nongynecologic pelvic disease.

Transvaginal sonography (TVUS) can distinguish structures localized anterior, posterior, and lateral to the uterus. When the transducer handle of transvaginal probe is moved posteriorly and then caudally, the bladder and the urethra are visible. When the handle is moved anteriorly, the tip of probe is aimed posteriorly, for a view of the rectosigmoid colon and anal canal. The lateral struc-

tures of the pelvis such as the iliac vessels, ureters, and lymph nodes require angling of the transducer toward the pelvic side wall. Because asymptomatic, nongynecologic lesions can be detected incidentally during TVUS performed for other purposes, knowledge of the possible appearances of these lesions is important in clinical practice. Placement of the sonographic (US) probe in proximity to the region of interest and the high resolution of the transducers have led to many improvements in the diagnosis of conditions involving gynecologic and nongynecologic organs. Further, TVUS is especially useful for the study of the female rectum and anal canal and for evaluating the base of the urinary bladder and the urethra.

Gastrointestinal applications

Although US is not widely used to diagnose bowel pathology, a variety of bowel lesions can be identified during routine abdominal and pelvic studies and TVUS. In lesions located deep in the pelvis, TVUS can differentiate gastrointestinal from gynecologic disease. It is important for the radiologist to be familiar with the normal and pathologic appearances of the bowel. The layers of the normal bowel wall can be seen as a series of alternating echogenic and hypoechoic concentric rings (“gut signature”). In adults the maximal wall thicknesses are 2–3 mm for the normal small bowel and 9 mm for the colon. Edema, inflammation, or neoplastic infiltration can increase the thickness of the bowel wall, decrease peristalsis, decrease the echogenicity of the bowel wall, and obliterate normal wall layering [1, 2]. The causes of bowel-wall thickening are multiple and include Crohn’s disease, primary and secondary neoplasms, lymphoma, and inflammatory processes (e.g., diverticulitis, appendicitis, and typhlitis).

Primary and secondary neoplasms, including those of the rectosigmoid colon and even the small intestine, can

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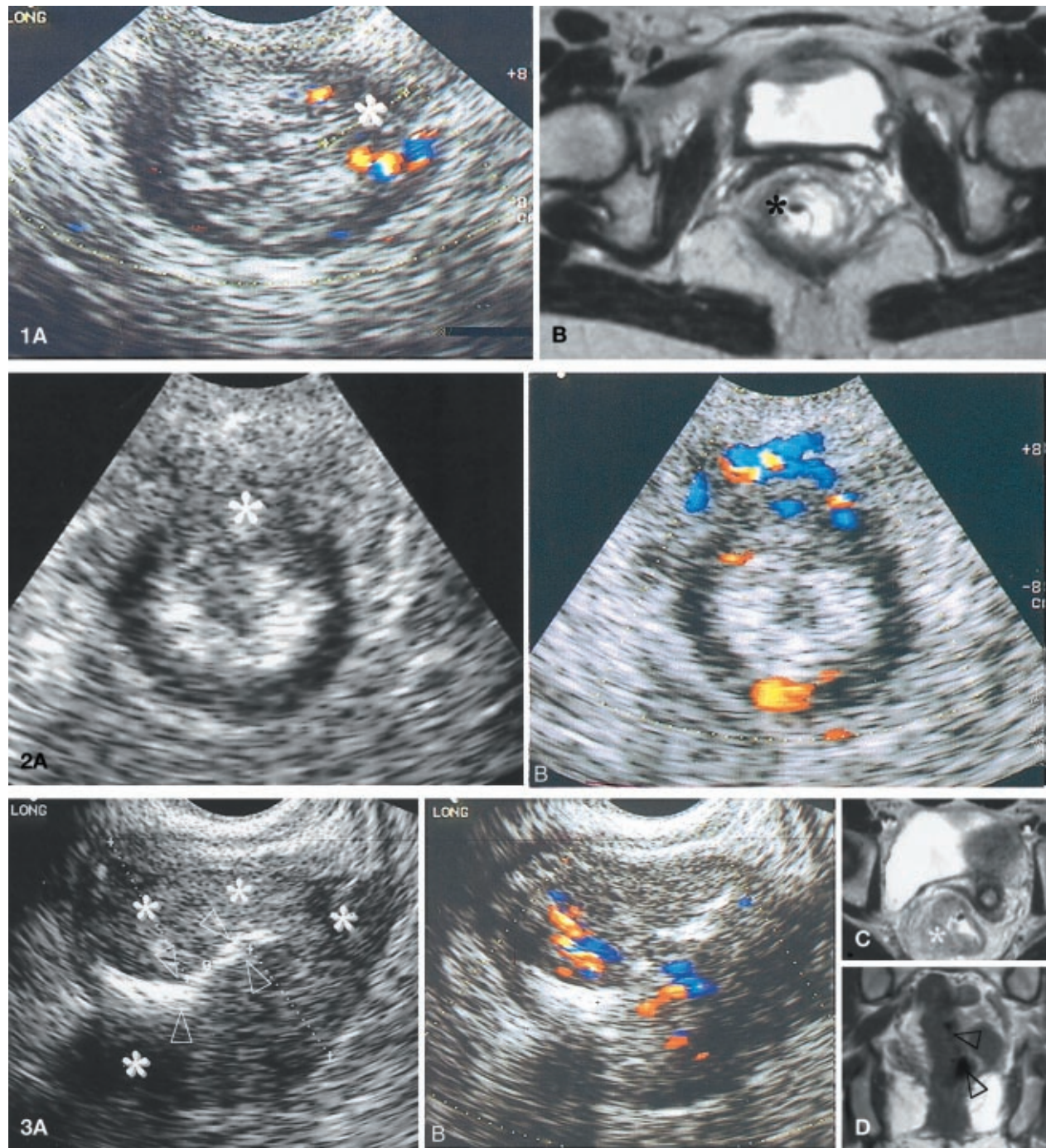


Fig. 1. Anorectal function carcinoma with transmural invasion. **A** Transverse TVUS image of the anal canal using color Doppler shows a small, round hypoechoic tumor mass (*) involving the left lateral wall. The neoplasm invades the mucosa and muscularis propria between the 2- and 3-o'clock positions. Signal flows are seen within the tumor mass. **B** Magnetic resonance T2-weighted turbo spin-echo image in the axial plane. The neoplasm (*) spreads to the external low-signal intensity ring corresponding to the outer muscular layer of the rectal wall.

Fig. 2. Anal carcinoma with transmural invasion. **A** Transverse TVUS image of the anal canal shows a small, round hypoechoic tumor mass (*) involving the full thickness of the anterior wall. The disappearance of the normal thick black ring corresponds to the internal anal sphincter,

continuous with the muscularis propria. The neoplasm is at the 12-o'clock position. **B** Multiple signal flows are seen inside the neoplasm on the color Doppler image.

Fig. 3. Annular rectal carcinoma with pseudokidney appearance on TVUS. **A** The black outer margin (*) represents the thickened rectal wall and the white inner region (arrowheads) is the gut lumen. **B** Color Doppler shows flow signals in the neoplasm. **C** Magnetic resonance T2-weighted turbo spin-echo image in the axial plane: the wall of the rectum (*) is irregularly thickened. There is infiltration of the perirectal fat with asymmetric thickening of the perirectal fascia. **D** Magnetic resonance T1-weighted image turbo spin-echo image in the coronal plane. The lumen (arrowheads) is almost obliterated by the tumor.

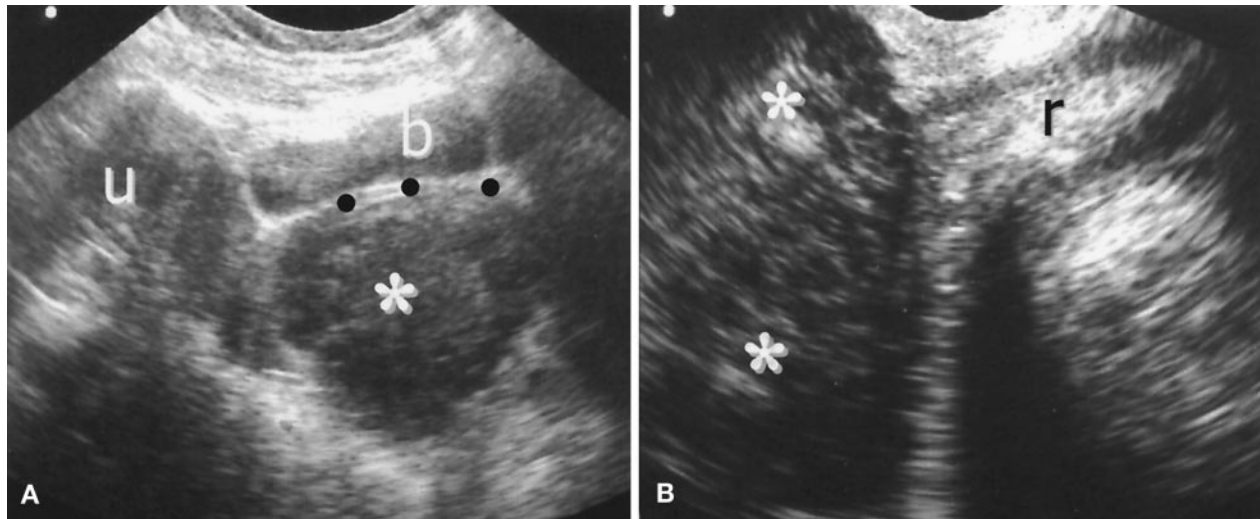


Fig. 4. Rectal leiomyosarcoma. **A** Transabdominal US shows a large, well-defined, pelvic mass (*) anteriorly displacing the vagina (black dots). **B** TVUS shows the mass at greater advantage and visualizes the lesion's origin from the lateral rectal wall. *r* rectum, *b* bladder, *u* uterus.

be seen on TVUS. TVUS is preferable for the evaluation of the perineal body and perianal inflammatory processes [3]. The tumor appears as focal mural thickening or as a localized, round, solid, hypoechoic or heterogeneous intraextraluminal mass (Fig. 1). US can be used to stage tumor infiltration within rectal wall and perirectal tissues (Fig. 2). The thickened, hypoechoic bowel wall appears in stark contrast to the echogenic mucosa and bowel contents, for a “pseudokidney” appearance. This is a characteristic finding of bowel lesions (Fig. 3). Intestinal leiomyosarcomas arise in the submucosa and appear as large, extraluminal, bulky, inhomogeneous, and occasion-

ally calcified masses (Fig. 4). These tumors can be more difficult to diagnose if their relation to the bowel wall cannot be determined. Adenomatous polyps can become carcinomatous. According to their glandular pattern, polyps are classified as tubular, tubulovillous, or villous. TVUS can detect villous adenomas with vascular pedicles, found most often in the rectosigmoid junction (Fig. 5).

Crohn's disease is a chronic disease of the gastrointestinal tract characterized by transmural inflammatory reactions, granulomas, skip lesions, fistula formation, and mesenteric abnormalities. TVUS is an optimal and pain-

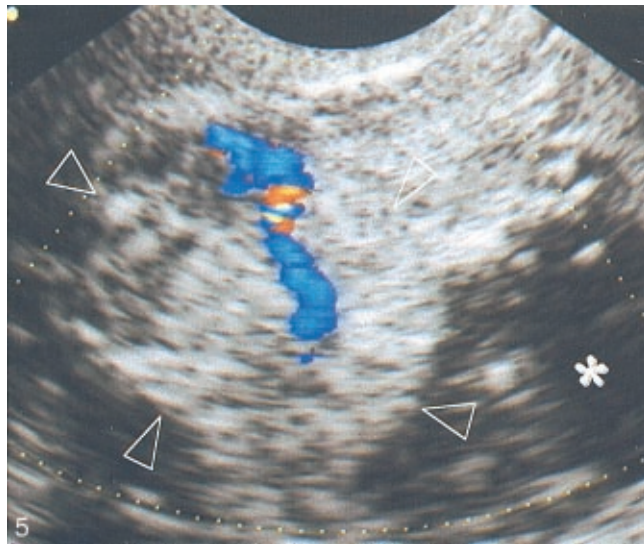


Fig. 5. Rectal villous adenoma. TVUS shows a protruding lesion (arrowheads) with a central vascular pedicle on color Doppler. A small adenoma with US gel distended the rectal lumen (*).



Fig. 6. Crohn's disease. There is symmetric and circumferential thickening of the terminal ileum with transmural edema and inflammation. Flow signals are seen in the submucosal layer.

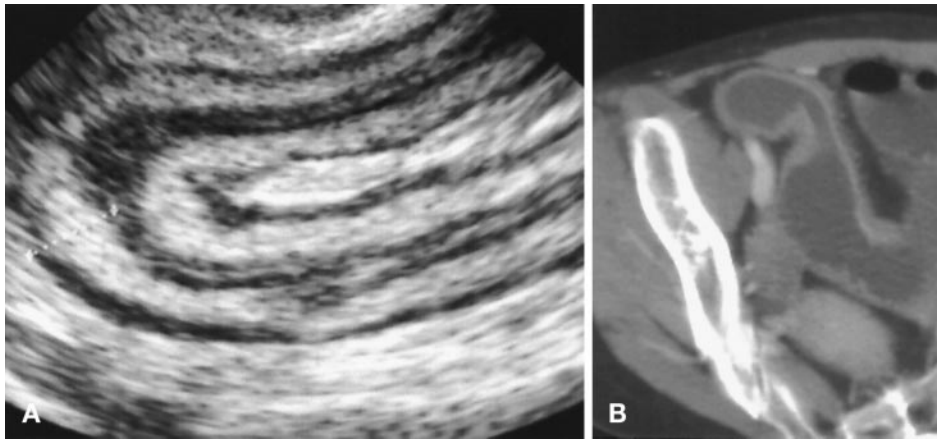


Fig. 7. Crohn's disease. **A** TVUS in the longitudinal plane shows thickened small bowel wall with preserved multilayered structure. **B** Pelvic computed tomography shows significant contrast enhancement of the inflamed wall. The periintestinal fat also shows inflammatory changes.

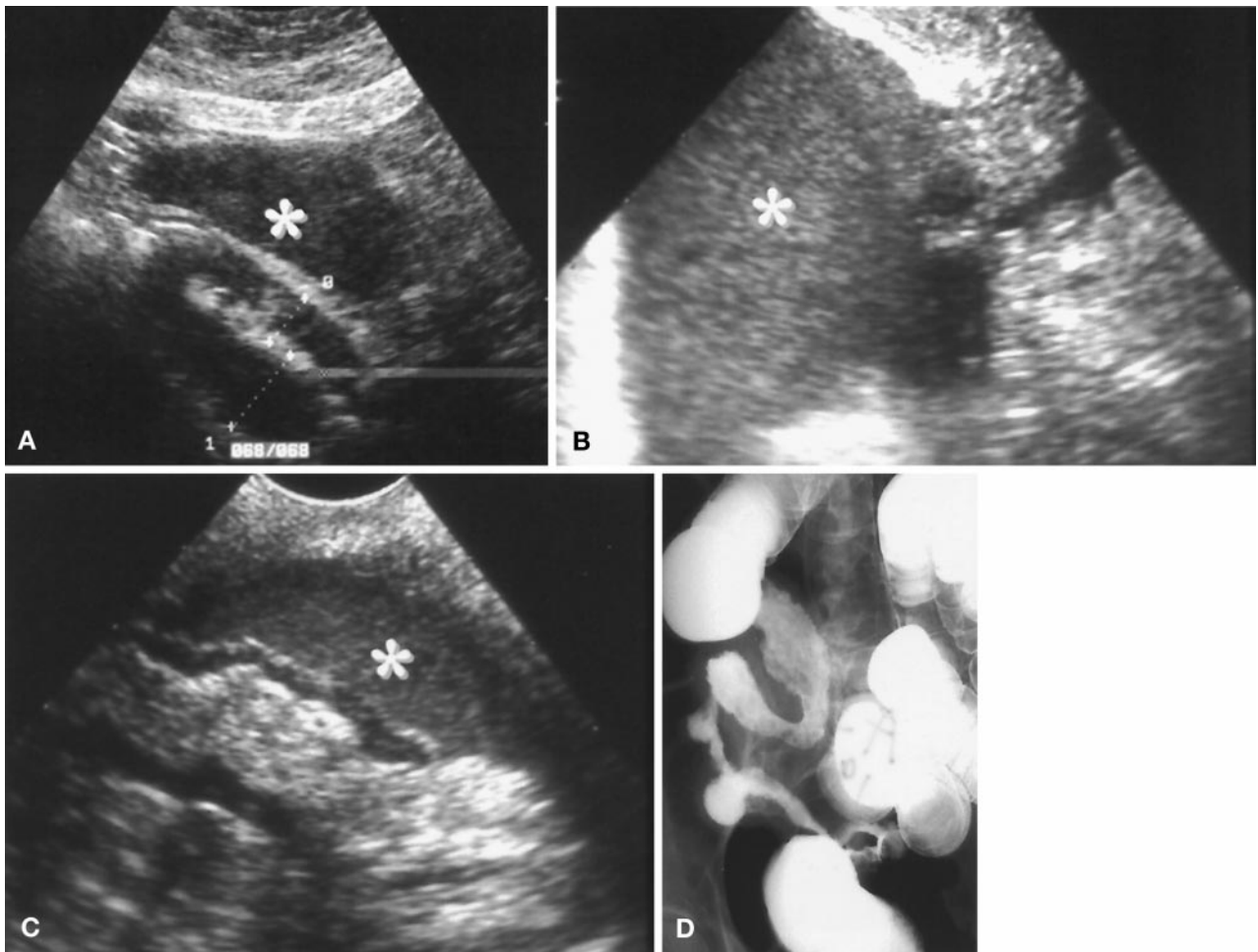


Fig. 8. Crohn's disease. **(A)** Longitudinal suprapubic US and **(B, C)** TVUS along the axial and sagittal planes show loss of mural stratification in the advanced stage of disease. An adjacent large abscess (*) is seen. **D** Barium enema study shows narrowing of the involved loops.

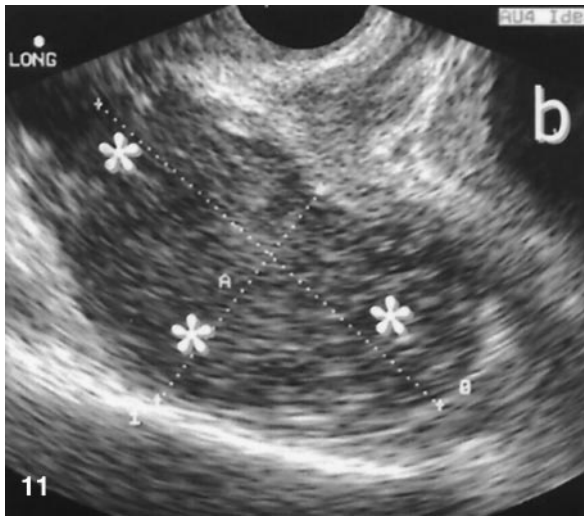


Fig. 9. Cytomegalovirus colitis. TVUS shows thickening of the sigmoid wall with mural stratification and a predominance of submucosa.

Fig. 10. Ileal distention from obstructing colon cancer. TVUS shows a dilated ileal loop filled only with fluid.

Fig. 11. Perirectal abscess after Miles operation. TVUS in the coronal oblique plane shows a large, well-defined echogenic mass (*). *b* urinary bladder.

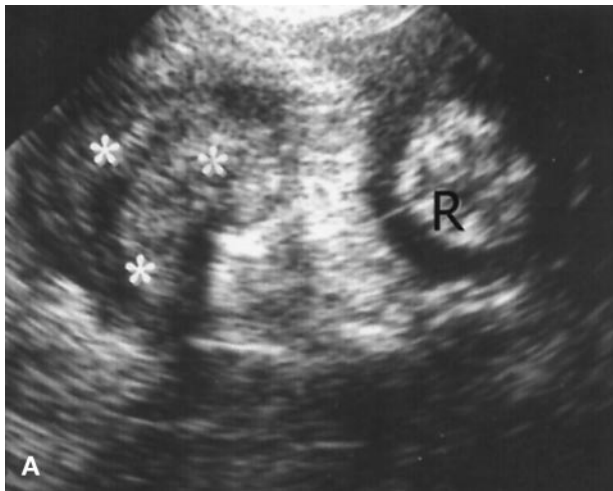


Fig. 12. Perirectal abscess. A TVUS shows a complex mass (*) associated with the rectum (*R*). A fistula is visible as a hypoechoic linear structure (arrowheads) coursing from the rectum to the abscess.

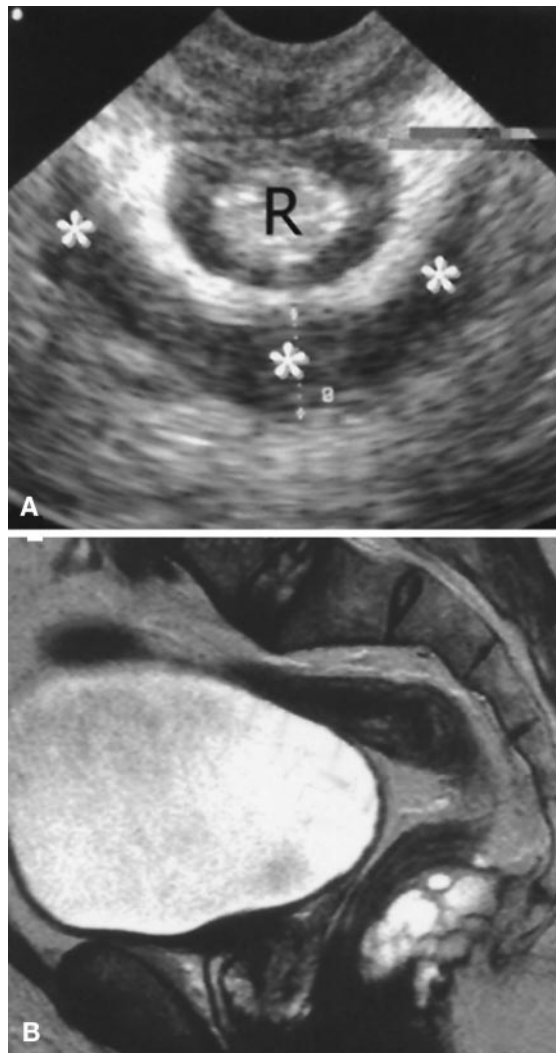


Fig. 13. Perirectal abscess. **A** Axial TVUS image shows a hypoechoic “horseshoe” mass (*) surrounding the rectum (R). Hyperechoic, inflamed perirectal fat is interposed between the gut and the abscess. **B** Magnetic resonance T2-weighted turbo spin-echo image shows the posterior rectal abscess.

less technique for characterizing perianal lesions in patients with Crohn’s disease. Imaging evaluation of the sigmoid colon and small intestine is performed by routine transvaginal techniques. Inflammation of mesenteric fat, gut-wall thickening (Fig. 6), mesenteric lymphadenopathy, strictures and fistulas can be visualized with US [4, 5]. If the multiple layers of the bowel wall (Fig. 7) can be visualized, then the disease process probably is not advanced and amenable to medical therapy. Fistulae and sinus tracks are common complications of Crohn’s disease. In the scarring phase of the disease, the bowel wall becomes fixed (Fig. 8) with chronic narrowing due to fibrosis, the so-called string sign [6].

The US appearance of opportunistic infection in the immunocompromised host (Fig. 9) is similar to that of

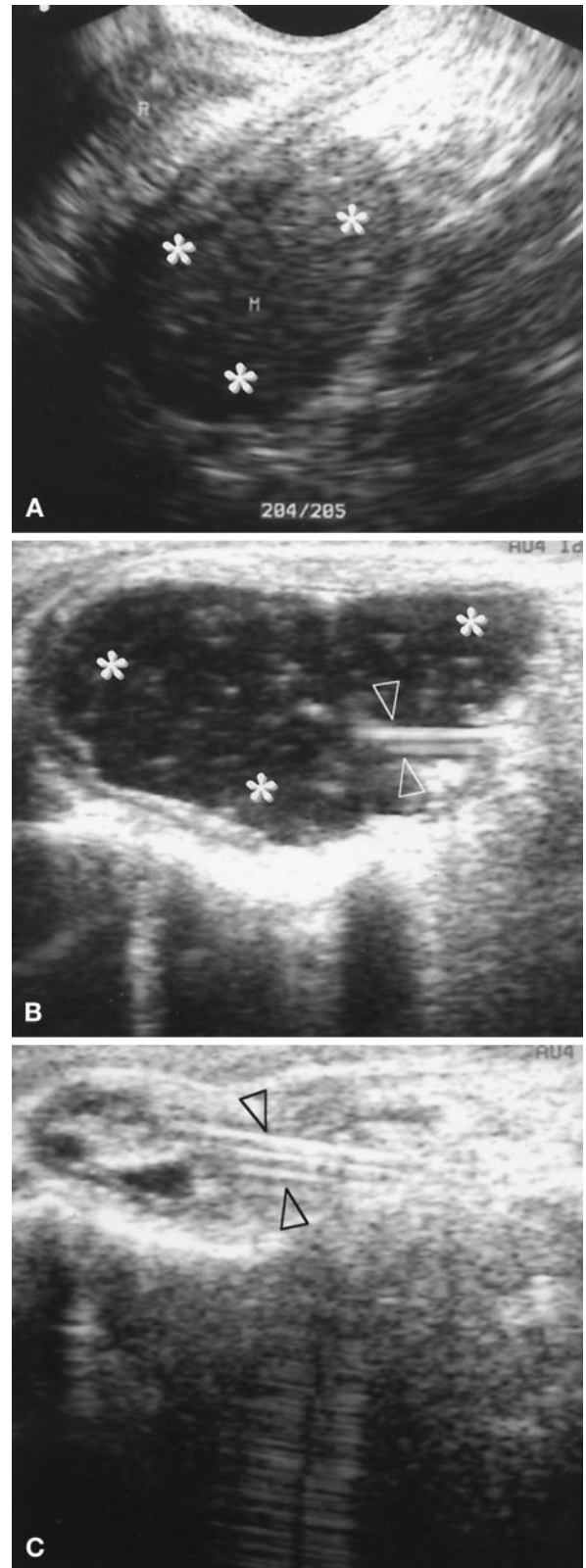


Fig. 14. Perirectal abscess. **A** TVUS shows a large echogenic fluid collection (*) adjacent to the margin of the rectum. **B, C** Transrectal US guided transperineal drainage: the catheter (arrowheads) is seen within the abscess cavity (**B**) before and (**C**) after drainage.

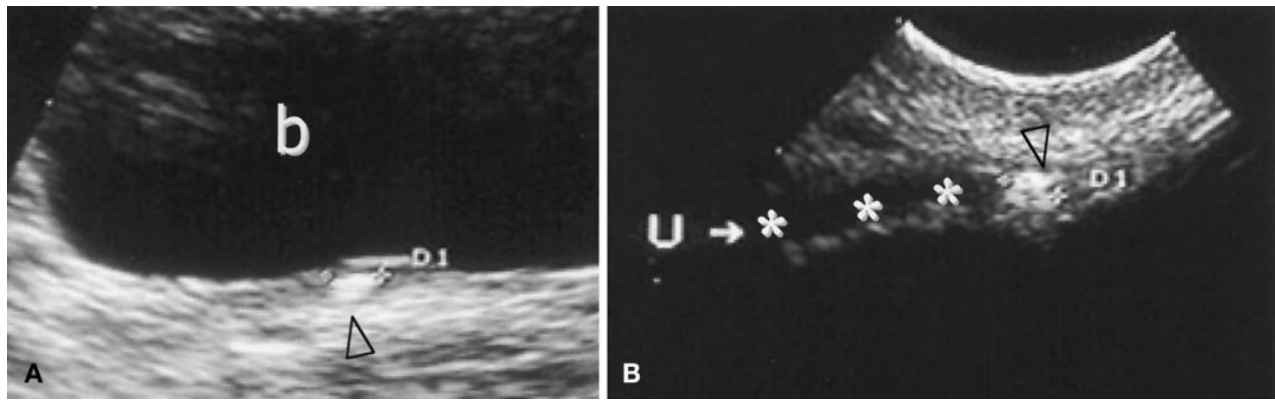


Fig. 15. Acute right flank pain. **A** Suprapubic US shows a well-defined, echogenic focus (*arrowhead*) at the ureterovesical junction. **B** Longitudinal TVUS shows better the dilatation of the intramural portion of the

ureter (*) caused by obstructing calculus (*arrowhead*) at the ureterovesical junction. *b* bladder, *u* uterus.

Crohn's disease: thickened, irregular mucosa and deep ulcerations [7]. Small bowel segments are identified during real-time scanning as fluid or gas-containing tubular structures with peristaltic activity. Bowel distention may result from obstruction or diminished peristalsis (Fig. 10), but US often cannot differentiate between these etiologies [8].

TVUS is useful for diagnosing pelvic abscesses. An abscess may be circumscribed and well defined or have irregular borders. The abscess appears as a nonspecific, complex fluid collection, often containing strong reflections, with posterior acoustic shadowing representing gas. The most frequent causes of abscess are pelvic inflammatory disease, diverticula, appendicitis, and postoperative complications (Fig. 11). In the appropriate clinical

setting, the detection of a thickened aperistaltic loop of bowel with haustrations within the left adnexa is suggestive of diverticulitis [9]. It is important to define the relation between the abscess and the pelvic structures (Figs. 12, 13). TVUS is excellent for interventional maneuvers through the vaginal vault [10]. Depending on the size of the abscess, simple aspiration may be preferable to drainage because transvaginal drainage is painful for the patient (Fig. 14).

On transabdominal ultrasound, the normal appendix frequently is not identified. In the normal appendix, the wall thickness is 2 mm or less, its overall diameter (outer to outer) is 5 mm or less, its lumen is empty, and an echogenic submucosal layer and peristalsis usually are visible [11]. TVUS in women of childbearing age with

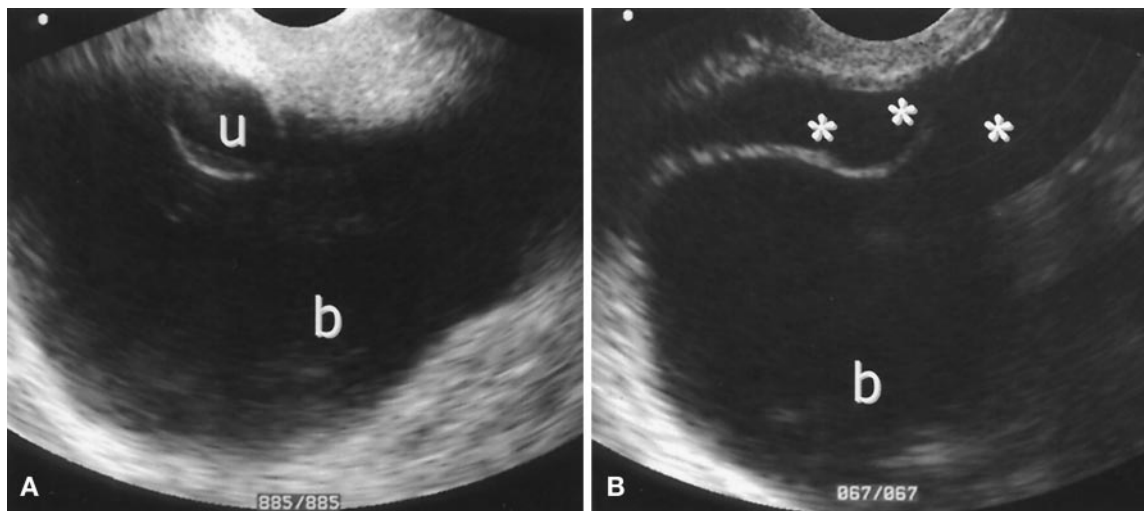


Fig. 16. Right ureterocele. **A** Longitudinal TVUS at the ureterovesical junction shows a ureterocele (*u*) projecting into the bladder lumen. **B** Oblique US of the ureteral meatus shows distal ureteral dilatation (*)

extending to the ureterovesical junction. No shadowing echogenic focus representing calculus or an intravesical mass is seen. *b* bladder.

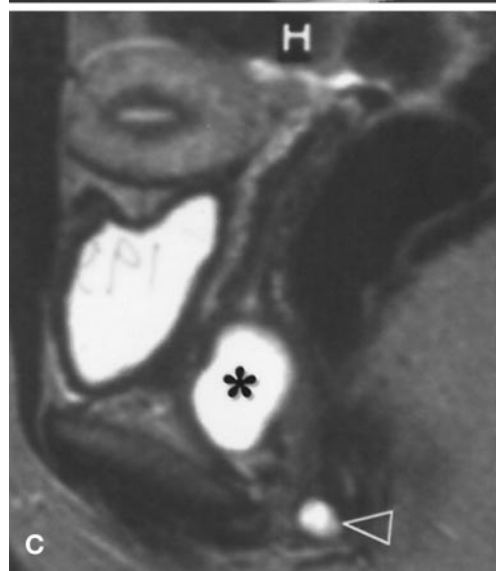
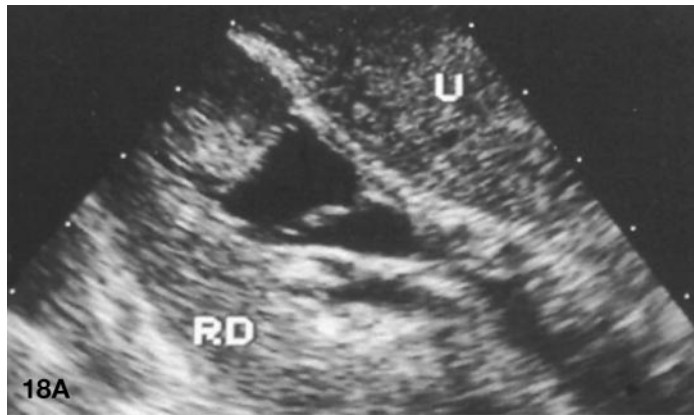
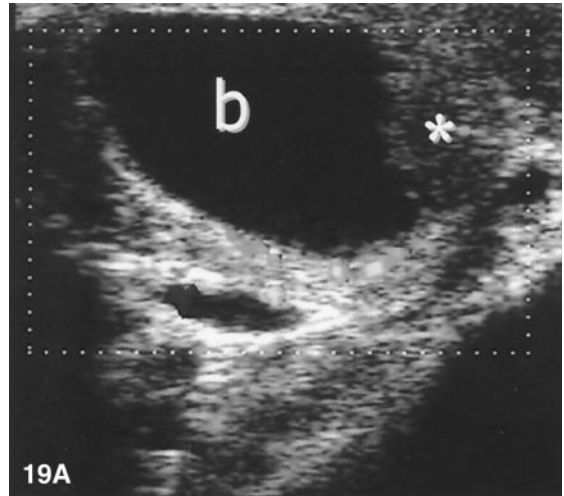
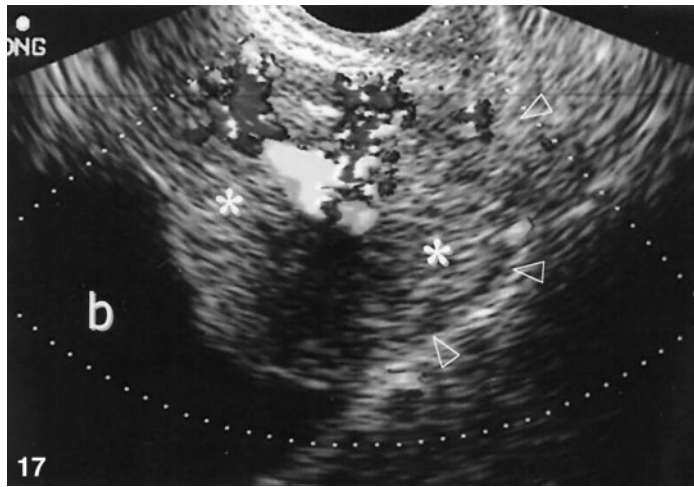


Fig. 17. Transitional cell carcinoma of the bladder. TVUS shows a partially filled bladder (*b*). A large tumor (*) projects into the lumen. Extravesical extension due to transmural spread is seen (*arrowheads*). The neoplasm shows flow signals on color Doppler (rendered in gray scale).

Fig. 18. Right pelvic kidney. **A** TVUS shows a reniform mass in the pelvis. **B** T2-weighted turbo spin-echo sagittal image confirms the US findings.

Fig. 19. Gartner duct cyst. **(A)** Transrectal US (rendered in gray scale) and **(B)** TVUS show a round, well-defined structure (*) located laterally within the vagina. The cyst did not communicate with the urethra (*white dots*), as confirmed by coronal TVUS, *b* bladder **C** T2-weighted turbo spin-echo sagittal image shows the cyst (*) posterior to the urethra and arising from the wall of the vagina. A small cyst of the Bartholin gland is located more distally (*arrowhead*).

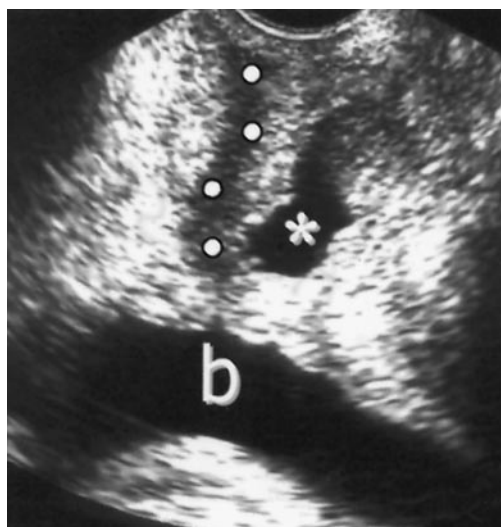


Fig. 20. TVUS shows a small urethral diverticulum (*) communicating with the urethral lumen (white dots). *b* bladder.

fever, pelvic pain, or pelvic mass can lead to a correct diagnosis of acute appendicitis by differentiating it from gynecologic and gastrointestinal disease [12].

Urinary applications

In patients with acute flank pain, US is commonly used to detect hydronephrosis and obstructing calculi. TVUS can be used to analyze more precisely the distal portion of the ureter and the ureterovesicle junction. In symptomatic female patients, vaginal US can detect distal ureteral calculi and possibly other ureterovesicle junction diseases [13]. The high-frequency probe used in vaginal US increases the resolution of a mildly dilated ureter. A distal ureteral calculus can be readily diagnosed because it is visible as an echogenic focus, usually with acoustic shadowing (Fig. 15). On TVUS, the visible length of the distal ureter is approximately 3 cm [13]. Most ureterocele project into the lumen of the bladder, but they also can project externally into the peritoneal space or retroperitoneum. A ureterocele is seen on US as a “cyst” within the lumen of the bladder (Fig. 16A). Partial or complete obstruction at the ureterovesical junction are usually associated (Fig. 16B). Stones, infections, focal inflammation, and tumors of the bladder are the abnormalities most likely to be detected on routine US and TVUS [12]. Transitional cell carcinoma can cause regional thickening of the bladder wall or polypoid mass that projects into the bladder lumen; vesical parietal neoplastic invasion is not uncommon, and its root can penetrate through the entire bladder wall and extend to the perivesical soft tissues [14] (Fig. 17). Ectopic endometrial tissue implanted on the serosal surface of the bladder occasionally protrudes into the bladder lumen.

Miscellaneous masses

If a reniform mass appears in the superior part of the pelvis, the renal beds should be evaluated. The empty renal fossa should suggest the diagnosis of a pelvic kidney. The displaced kidney is positioned in the iliac fossa or the true pelvis (Fig. 18) and can be asymptomatic. Alternatively, complications such as infection or hydronephrosis can cause symptoms. Urachal cysts, lymphoceles, duplication and mesenteric cysts, and paraovarian cysts can be visualized with TVUS [8]. Gardner duct cyst is a retention cyst that occurs along the Wolffian duct remnant. Gartner duct cysts can be located anywhere from the cervix to the introitus on the anterolateral wall and usually are asymptomatic but can become large and obstruct the urethral orifice. They frequently form a tiny string of cysts and are identifiable on endovaginal US (Fig. 19).

Urethral diverticulum is a cystic dilatation of a portion of the periurethral ductal system. A transvaginal probe close to the diverticulum can visualize its connection to urethral lumen (Fig. 20), providing a better evaluation of diverticula than voiding cystourethrography. TVUS can visualize location (proximal, middle, distal urethra), size, number, expansion (lateral, posterior), contents (pus, stones, malignancy), and thickness of diverticular walls [15]. TVUS can be used to measure the size of urethral carcinoma and its relation to the vaginal wall [15]. Urethral carcinoma appears as a poorly defined, nonhomogeneous, hypoechoic lesion. Although suprapubic US can show masses or fluid in the pouch of Douglas, TVUS is superior in its characterization of both entities. Small quantities of peritoneal fluid may be identified, and char-

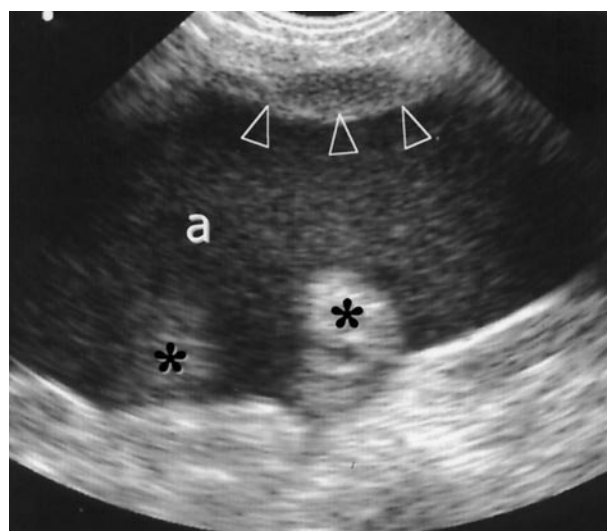


Fig. 21. Intraoperative drop metastases from hepatocellular carcinoma. TVUS shows grossly particulated ascites (*a*) due to hemoperitoneum, a focal plaque-like thickening of the parietal peritoneum (arrowheads) of the pelvic side wall, and two small peritoneal implants (*).

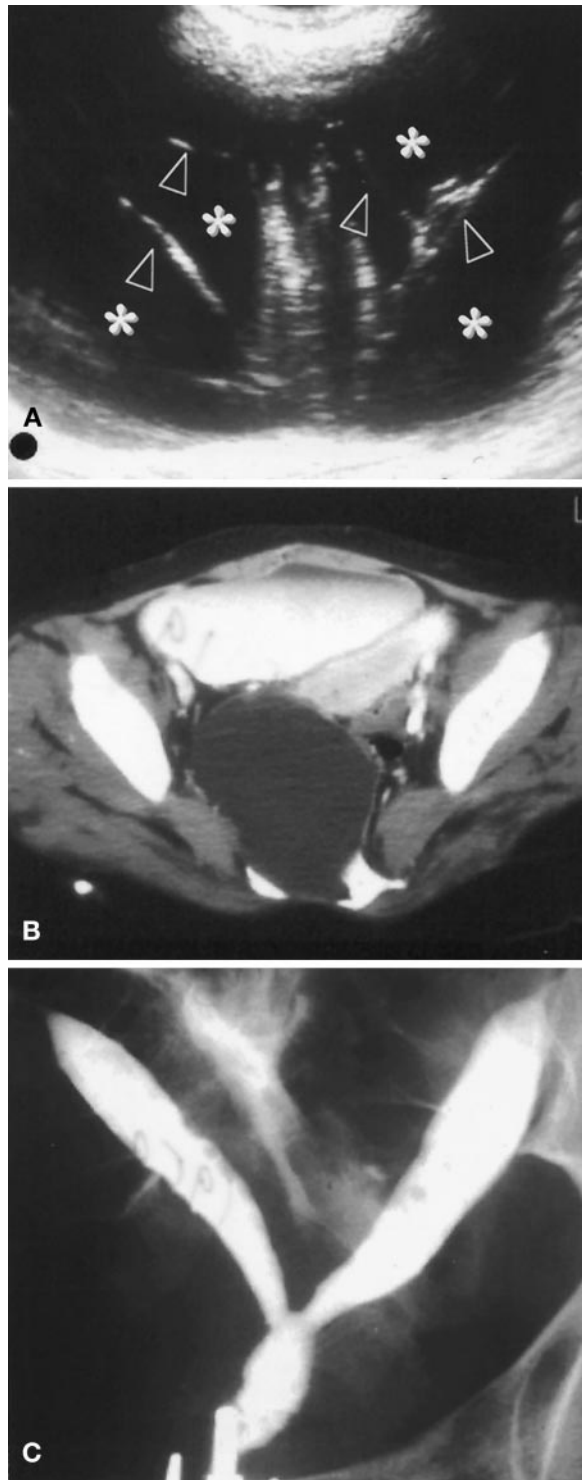


Fig. 22. Anterior sacral myelomeningocele. **A** TVUS shows an anterior myelomeningocele (*) containing hyperechoic, symmetric, linear structures corresponding to the fibers of the cauda equina (arrowheads). **B** Enhanced pelvic computed tomography better demonstrates the sacral origin of the fluid mass in the presacral space. **C** Hysterosalpingography identifies the coexistence of a bicornuate unicollis uterus.

acterization of free fluid often allows a correct diagnosis of the underlying disease process [10]. Implants on the visceral or parietal peritoneal surfaces (Fig. 21) suggest tumor or peritoneal carcinomatosis [10]. Masses in the presacral space and along the side walls of the true pelvis can be identified and characterized with TVUS (Fig. 22).

Conclusion

TVUS can be a useful method for evaluating nongynecologic structures of the female pelvis. We recommend TVUS for all patients with uncertain abnormalities detected on routine suprapubic US. In those patients, TVUS can allow accurate examination of the bowel, urinary tract, pelvic side walls, presacral space, cul-de-sac, and vascular structures of the true pelvis.

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