Imaging Features of Female Genital Tuberculosis and its Mimics

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Abstract

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► hydrosalpinx
► hysterosalpingography
► peritoneal tuberculosis
► tuberculosis
► tubo-ovarian mass

Tuberculosis involving the female genital tract causes significant morbidity in women in the reproductive age group, where it is often associated with infertility. The fallopian tube is the most common part to be affected by the disease. Since female genital tuberculosis is a paucibacillary disease, organisms are often not detected. Therefore, multimodality imaging features play an important role in the diagnosis. A gamut of radiological investigations including hysterosalpingogram, ultrasound, and cross-sectional modalities like computed tomography and magnetic resonance imaging are available in the evaluation of disease. The key imaging differentials vary depending upon the part of the genital tract affected. This review will discuss the imaging appearances of tuberculosis of the female genital tract on various imaging modalities and their differential diagnosis.

Introduction

Genital tuberculosis accounts for 9% of all extrapulmonary tuberculosis cases.[1] In a study, genital tuberculosis was diagnosed in 22.5% patients with pulmonary and 15% patients with abdominal tuberculosis.[2] Tuberculosis involving the female genital tract is a significant problem in women of reproductive age group and represents an important cause of infertility. While it can involve any part including the ovaries, fallopian tubes, uterus, cervix, and vagina, the fallopian tubes are the most commonly affected by the disease (►**Box 1**). In a study, the prevalence of genital tuberculosis in tubal factor infertility was 48.5%.[3] The presentation is often indolent with nonspecific signs and symptoms mimicking other gynecological problems in the form of infertility, dyspareunia, menstrual irregularities, and chronic pelvic inflammatory disease (PID), although it may be incidentally detected in patients being suspected of other diseases.[4] The classic triad of clinical presentation is infertility, menstrual irregularity, and chronic pelvic pain. The low bacterial load in genital tuberculosis makes isolation of organisms difficult.

The absence of sensitive and specific tests in the diagnosis of genital tuberculosis makes it imperative for the radiologist to recognize imaging features in an appropriate clinical context and be the first to suggest a diagnosis of tuberculosis. In this pictorial review, we will discuss the key imaging findings of tuberculosis involving the female genital tract on different imaging modalities including hysterosalpingography (HSG), ultrasound (US), and cross-sectional imaging (computed tomography [CT] and magnetic resonance imaging [MRI]) along with the key imaging differentials.

Imaging Findings

Hysterosalpingography

In patients who present with primary or secondary infertility, HSG is the gold standard to evaluate the internal structure of the female genital tract and is done to evaluate for tubal

Box 1 Etiopathogenesis of female genital tuberculosis

Etiological agent: *Mycobacterium tuberculosis*
Patterns of transmission:
Hematogenous spread
Lymphatic spread
Direct spread
Sexual transmission from semen
Part of female genital tract affected:
Fallopian tube 90%
Uterus 50%
Ovary 20%
Cervix 5%
Vulvovaginal rare

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patency. A spectrum of findings may be seen on HSG in cases of tuberculosis (►**Table 1**).

Fallopian Tubes

On a plain film, the fallopian tubes may show linear streaky areas of calcification which should be differentiated from other causes of pelvic calcification such as calcified pelvic lymph nodes, calcific foci in dermoid cysts, calcifications within uterine myomas, and phleboliths.[5]

The most common presentation of tubal disease is in the form of *occlusion* occurring at the level of the isthmus, ampulla, or the cornua. Tubal occlusion occurring at the distal ampulla gives rise to a dilated tube with club-shaped appearance to the ampulla giving rise to "tobacco-pouch" appearance. Tubal occlusion, however, is not specific to tuberculosis and may be caused by chlamydial or gonococcal infection, endometriosis, inflammatory bowel disease, previous pelvic surgery, and intrauterine contraceptive devices.[5]

Tubal dilatation occurring in salpingitis is seen as hydrosalpinx with the dilated tube coiled in a C- or S-shaped pattern (►**Fig. 1**). The tubes can develop alternate areas of narrowing and dilatation representing strictures giving a "beaded tube" (►**Fig. 1**). Absence of the normal tortuosity of the fallopian tubes can also give rise to a "pipe stem tube" appearance as a sequelae to healed infection.[5]

Mucosal involvement of the tube by the bacilli results in ulceration, irregularity in contour, and diverticula formation giving rise to *salpingitis isthmica nodosa pattern* (►**Fig. 1**).[6]

Table 1 Imaging features suggestive of TB on hysterosalpingogram

Serial no.	Sign/Imaging appearance	Description	Imaging differentials
Fallopian tube			
1.	Tubal occlusion	Absence of contrast spill on HSG	PID, endometriosis, inflammatory bowel disease, previous surgery, IUCD
2.	Hydrosalpinx (tubal dilatation)	C- or S-shaped dilated fallopian tubes	PID
3.	Beaded tube	Alternate areas of narrowing and dilatation	PID
4.	Pipe-stem appearance	Straight appearance of tube with a loss of normal tortuosity	PID
5.	TB-salpingitis isthmica nodosa (SIN) pattern	Irregularity in tubal contour with larger, asymmetric diverticular outpouchings and not limited to isthmic portion of the tube	Salpingitis isthmica nodosa
6.	Peritubal halo/Halo sign	Circumferential lucency or cloudy appearance due to thickening of the tube walls	PID, endometriosis, radiotherapy, previous surgery
7.	Loculated spill	Irregular-shaped contrast collections around the fimbrial end of the tube	PID, endometriosis, radiotherapy, previous surgery
Uterus			
1.	Intrauterine synechiae	Irregular linear filling defects	PID, prior dilatation and curettage, prior surgery
2.	T-shaped uterus	Scarring along short and long axis resulting in T-shaped cavity	Exposure to diethylstilbestrol (DES)
3.	Pseudo-unicornuate uterus or pseudoseptate uterus	Postinfective scarring obliterating half of the cavity or decreased capacity in the region of the fundus	Unicornuate uterus Septate uterus
4.	Intravasation	Contrast entering the veins and lymphatics of the uterus	Any cause of obstruction, post-endometrial instrumentation
5.	Dwarfed uterus	Shriveled uterine cavity causing reversal of the uterus to cervix ratio	Congenital hypoplasia of the uterus

Abbreviations: HSG, hysterosalpingography; IUCD, intrauterine contraceptive device; PID, pelvic inflammatory disease; TB, tuberculosis.
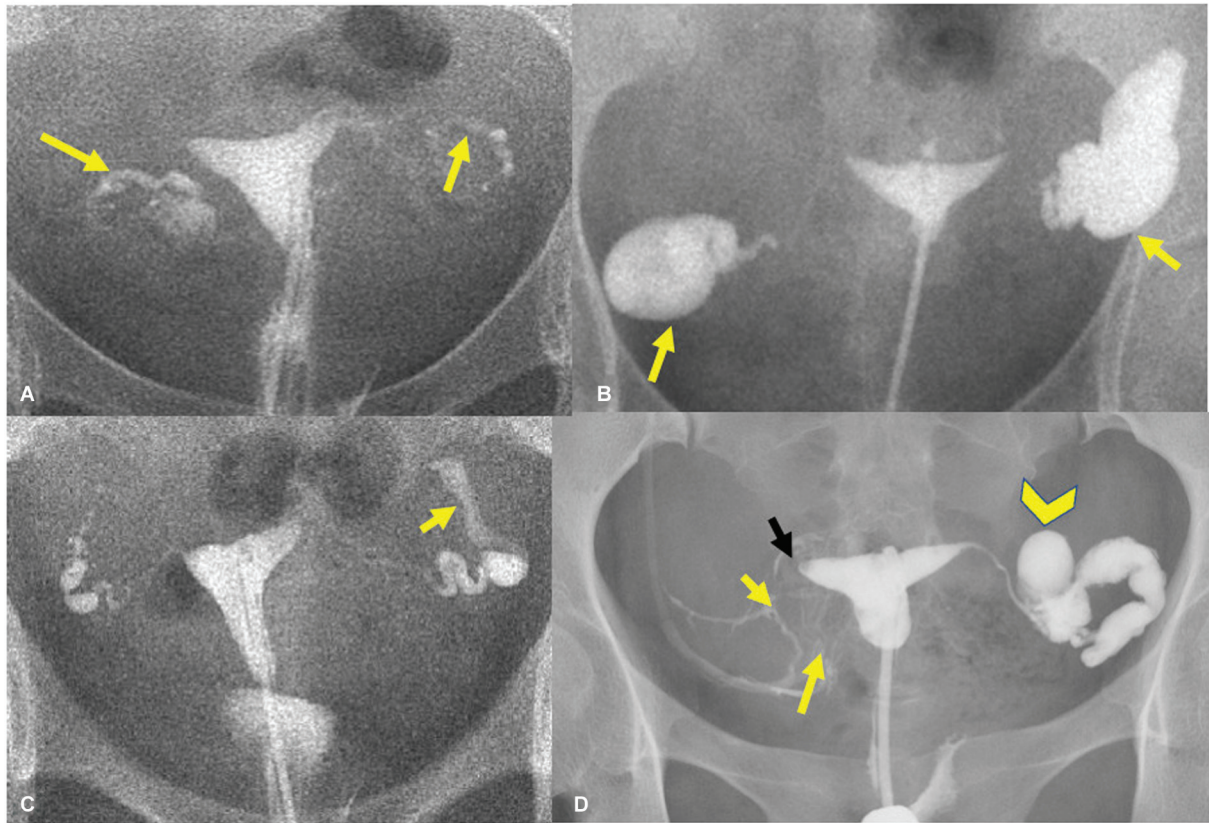
Fig. 1 Typical appearances of tuberculosis involving the fallopian tubes on hysterosalpingography (HSG): (**A**) Beaded appearance of bilateral fallopian tubes with loculated spill on the right side. (**B**) Bilateral hydrosalpinx. (**C**) Bilateral terminal hydrosalpinx with loculated spill (arrows). (**D**) Cornual occlusion (black arrows) with intravasation of contrast on the right side (arrows) and hydrosalpinx with loculated spill on the left side (arrow heads).

Peritubal adhesions develop as sequelae to healing tuberculosis and are indicated by the presence of corkscrew tubes, peritubal halo, fixed position of tubes, and loculated contrast spill (►**Figs. 1** and **2**). Loculated spillage of contrast is seen as irregular-shaped contrast collections around the fimbrial end of the tube that contrasts from a thin smooth layer coating the peritoneal cavity which indicates free peritoneal spill. A peritubal halo is circumferential surrounding area of lucency around the tubes due to thickening of the tubal walls and is referred to as the "halo sign" (►**Fig. 2**). Peritubal/pelvic adhesions may, however, also be seen in PID, endometriosis, or in patients who have had prior surgery or radiotherapy.

Uterus

The second most common organ involved in the female genital tract is uterus and involvement occurs by direct spread from the fallopian tubes. Usually, the endometrium is affected, the myometrium is rarely involved in 8% of the cases.[7] Infection of the uterine cavity can result in endometritis which initially results in mild inflammation along the mucosa and in advanced cases progresses to ulceration and adhesions. Mucosal involvement can manifest as an *irregular mucosal outline* of the uterine cavity on the HSG. This, however, is not specific for tuberculosis and may be seen with any cause of PID. *Intrauterine synechiae* and *adhesions* are seen as presence of multiple irregular linear filling defects giving a lacunar appearance with lack of distension of the uterine cavity (►**Fig. 3**).[8] Infertility associated with intrauterine adhesions is termed as Asherman's syndrome. However, a similar appearance can occur in patients with other infections or prior history of dilatation and curettage and surgeries (►**Fig. 4**). Scarring resulting from the disease can cause shortening of the uterus along both the long and short axis resulting in the shrinkage of normal triangular-shaped uterine cavity into a *T-shaped cavity*.[6] This closely mimics the T-shaped uterine cavity found in patients with exposure to diethylstilbestrol. Postinfective scarring can result in one-sided obliteration of the uterine cavity which is referred to as "*pseudo-unicornuate*" *appearance*, which mimics the appearance of a unicornuate uterus. Obliteration in the mid-body/fundus can mimic the appearance of a septate uterus, however, the cavity outline is usually irregular (►**Fig. 3**). Extensive synechiae can lead to complete obliteration of the entire uterine cavity giving rise to a "finger in glove" appearance.[9] Extensive adhesions cause a small shriveled uterine cavity with disproportion between the uterine cavity and cervical canal "dwarfed uterus." While attempting contrast opacification of the uterine cavity, venous and lymphatic "intravasation" may be seen.[10] However, this contrast intravasation may also be seen during early phase of the menstrual cycle, after endometrial instrumentation or any cause of obstruction.[9] Advanced cases of tuberculosis may result in "collar stud abscess" formation
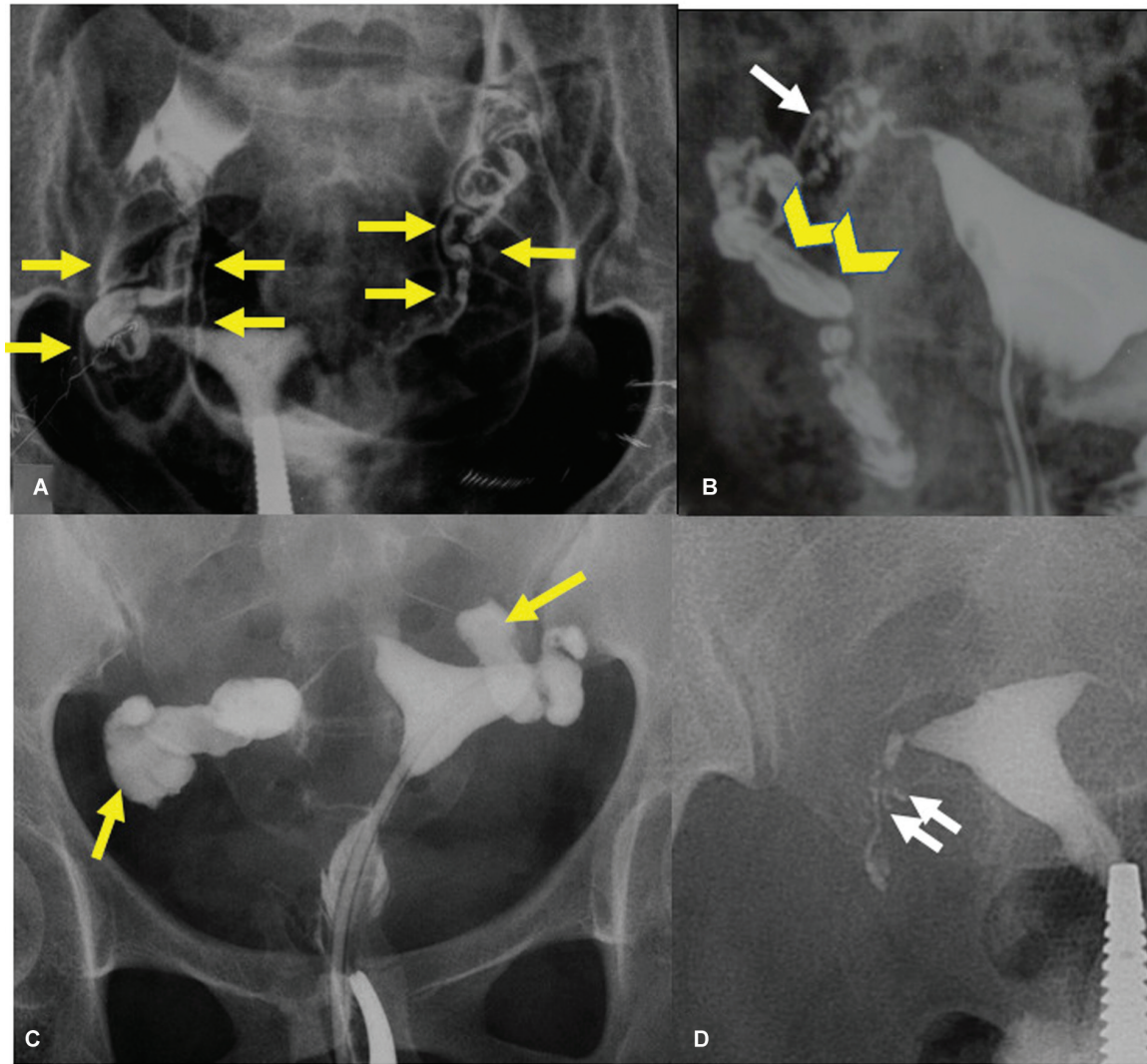
Fig. 2 Typical appearances of tuberculosis involving the fallopian tubes on hysterosalpingography (HSG): (**A**) Vertically oriented fallopian tubes with peritubal halo (arrow) indicated peritubal adhesions secondary to tuberculosis. (**B**) Thickened mucosal folds in the dilated right fallopian tube (arrow heads) and salpingitis isthmica nodosa (SIN) appearance (white arrows). (**C**) Bilateral tubes show tobacco pouch appearance. (**D**) Salpingitis isthmica nodosa (SIN) appearance involving the right fallopian tube (white arrows).
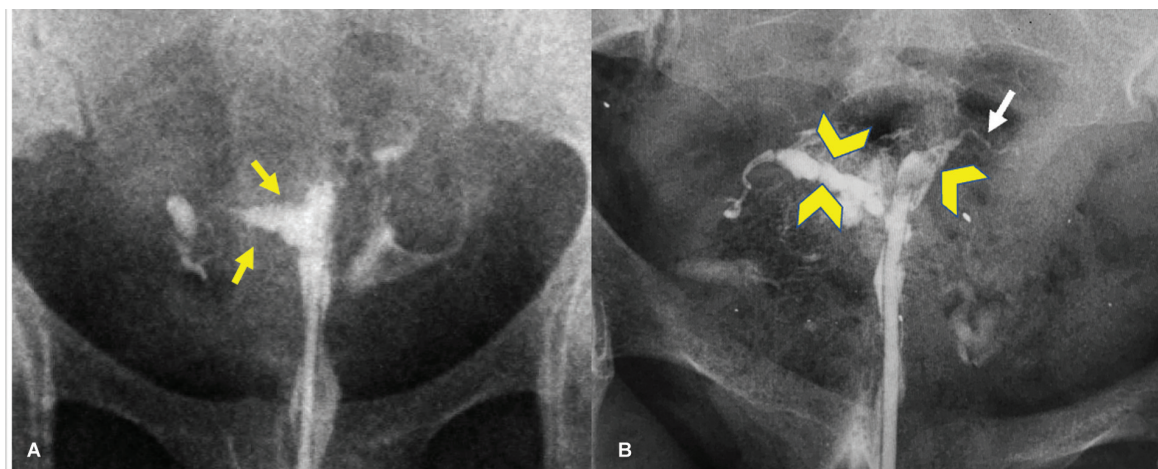
Fig. 3 Typical appearance of tuberculosis involving the endometrium on hysterosalpingography (HSG): (**A**) Irregular outline (arrows) of the endometrial cavity—endometritis. (**B**) Irregular contour of uterine cavity (arrow heads) and decreased capacity in the fundus giving a pseudoseptate appearance. Absence of normal tortuosity of the left fallopian tube with a straight pipe-like appearance (white arrows).
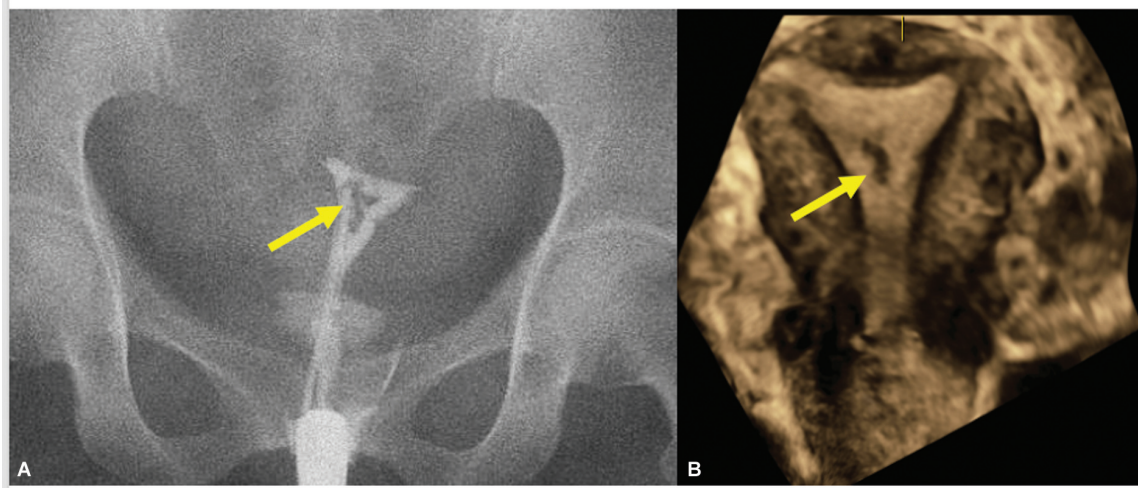
Fig. 4 Nontubercular endometrial disease on hysterosalpingography (HSG): In this case of Asherman's syndrome that occurred postdilatation and curettage done for retained products of conception, (**A**) HSG image showing irregular filling defect (arrows) suggestive of synechiae with irregular outline. (**B**) Three-dimensional (3D) ultrasonography (USG) image showing intrauterine synechiae, uterine contour however was regular with normal outline.

which appears as an ulcer with narrow neck and a broad base.[5]

Cervix

Involvement of the cervix is usually secondary to tubercular salpingitis or endometritis and HSG may show irregular contour of the cervical canal and diverticula giving rise to a feathery appearance or adhesions in the form of linear and serrated filling defects. There may be stenosis of the cervical canal with reduced internal os diameter to < 1 mm.[6]

Using the HSG findings (►**Fig. 5**), Klein's criteria have been proposed to diagnose genital tuberculosis in females: (1)

S no.	Imaging Feature	
1.	Calcified lymph nodes or smaller irregular linear or nodular calcifications in the adnexa	
2.	Obstruction of the fallopian tubes in the zone of transition between the isthmus and ampulla	
3.	Multiple constrictions along the course of the fallopian tubes	
4.	Endometrial adhesions and/or deformity or obliteration of the endometrial cavity in the absence of history of curettage or surgical termination of pregnancy.	

Fig. 5 Klein's criteria for diagnosis of female genital tuberculosis on hysterosalpingography (HSG) (adapted from ref. 11).

Table 2 Summary of imaging features of tuberculosis on US

Imaging features of tuberculosis on US
Fallopian tubes: Hydrosalpinx – Dilated tubular structures with incomplete septations Pyosalpinx – Dilated fallopian tubes distended with echogenic content Thickening of tubes – Mucosal wall thickening, "cogwheel sign" on cross-section Ovaries: Multilocular cystic lesions with echoes and no solid component Bulky ovaries with echogenic calcific foci representing granulomas Uterus: Irregular thickening of the endometrium Calcific foci within the endometrial cavity Synechiae as focal areas of discontinuity disrupting endometrium Synechiae – linear echogenic bridges within the endometrial cavity on SIS Cervix: Bulky Associated findings: Ascites Omental thickening/caking Necrotic and conglomerated lymphadenopathy

Abbreviations: SIS, saline infusion sonography; US, ultrasound.

calcified lymph nodes or smaller irregular linear or nodular calcifications in the adnexa, (2) obstruction of the fallopian tubes in the zone of transition between the isthmus and ampulla, (3) multiple constrictions along the course of the fallopian tubes, and (4) endometrial adhesions and/or deformity or obliteration of the endometrial cavity in the absence

of history of curettage or surgical termination of pregnancy.[11]

Ultrasound

US is often the first diagnostic modality in suspected female genital tract pathologies and a spectrum of imaging findings may be seen based on the part of the genital tract involved (►Table 2). Being a readily available investigation with no radiation exposure it is also one of the most cost-effective modalities.

Fallopian Tubes

The most common presentation of tuberculosis on US is dilated fallopian tubes showing thickened edematous walls. The dilated tubes need to be differentiated from ovarian cysts by presence of incomplete septations (mucosal folds) in tubes versus complete septations in ovarian lesions.[12] When the tubes are seen in cross-section, the thickened edematous folds give the appearance of a cogwheel referred to as the "cog wheel sign" (►Fig. 6). The tubes may be distended with clear fluid or fluid with internal echoes within (pyosalpinx) (►Fig. 6). Pyosalpinx closely mimics hematosalpinx/endometriomas both of which show adnexal cysts distended with echogenic fluid and debris within. The presence of hydrosalpinx/pyosalpinx is not specific for tuberculosis and may be seen with PID. Salpingitis may manifest as thickening of the fallopian tubes walls (> 5 mm in thickness). The presence of ascites markedly improves the detection of salpingitis. PID is an important differential of genital tuberculosis and differentiation between the two entities has important management implications. While in genital tuberculosis, transmission is via hematogenous spread, in PID, transmission is via sexual route. On imaging, obstruction occurring along with tubal dilatation is less
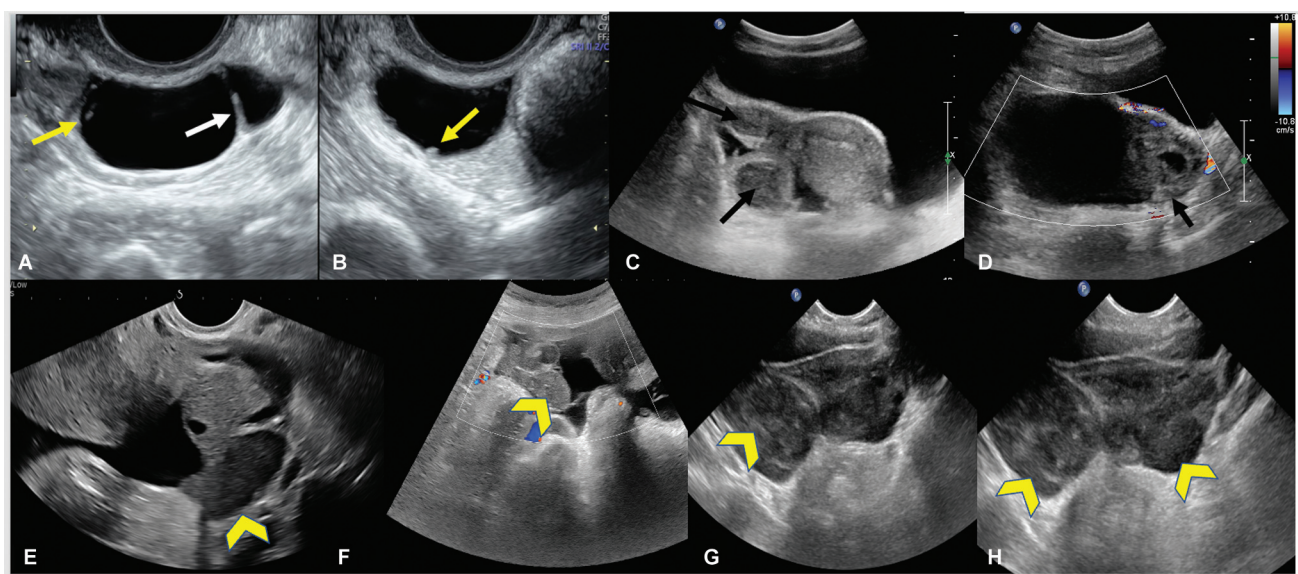
Fig. 6 Typical appearances of adnexal tuberculosis on ultrasonography (USG): (**A**, **B**) Hydrosalpinx in cross-sectional view showing cogwheel sign (arrows) and incomplete septations (white arrow). (**C**, **D**) Bilateral adnexa showing multiloculated cystic lesions with echoes/debris within (black arrows). (**E**, **F**) Pelvic ascites and bilateral adnexa showing tubular structures with echoes within (arrow heads). (**G**, **H**) Bilateral dilated tubular lesions in the adnexa with internal echoes—pyosalpinx (arrow heads).

common in tuberculosis, while tends to be more common in PID. Peritoneal involvement is more common in tuberculosis, but rare in PID. The adnexal lesions show irregular nodular walls and may show calcification in tuberculosis, while in PID, the adnexal lesions are usually more uniform and do not show calcifications.[12] PID more commonly shows associated cervicitis and endometritis.

Ovaries

Tubercular involvement of the ovaries (tubercular oophoritis) usually occurs concomitantly with tubal involvement and can manifest in the form of multilocular cysts with no solid component.[13] The multilocular cystic lesions can show thick or thin irregular walls with mild peripheral vascularity. On US, these cystic lesions can show internal echoes or mobile debris (►**Fig. 6**). In association there may be other features such as salpingitis/hydrosalpinx, ascites, and necrotic lymphadenopathy. The differentials for multilocular cysts with no solid component include PID, endometrioma, and mucinous cystadenoma. However, US has a low specificity in differentiating these entities from tuboovarian tuberculosis and the clinical presentation; serum markers like cancer antigen-125 (CA 125), carcinoembryonic antigen, and imaging (CT and MRI) may play a role in differentiation.[14] MRI has a higher sensitivity and specificity of 100 and 90%, respectively, as compared to transvaginal US which has a sensitivity and specificity of 56 and 86%, respectively, in the diagnosis of tubercular adnexal disease.[15]

Uterus

Acute endometritis has nonspecific features, however, can show irregular hypoechoic thickening of the endometrium (►**Fig. 7**).[16] Chronic endometritis can show hyperechoic foci
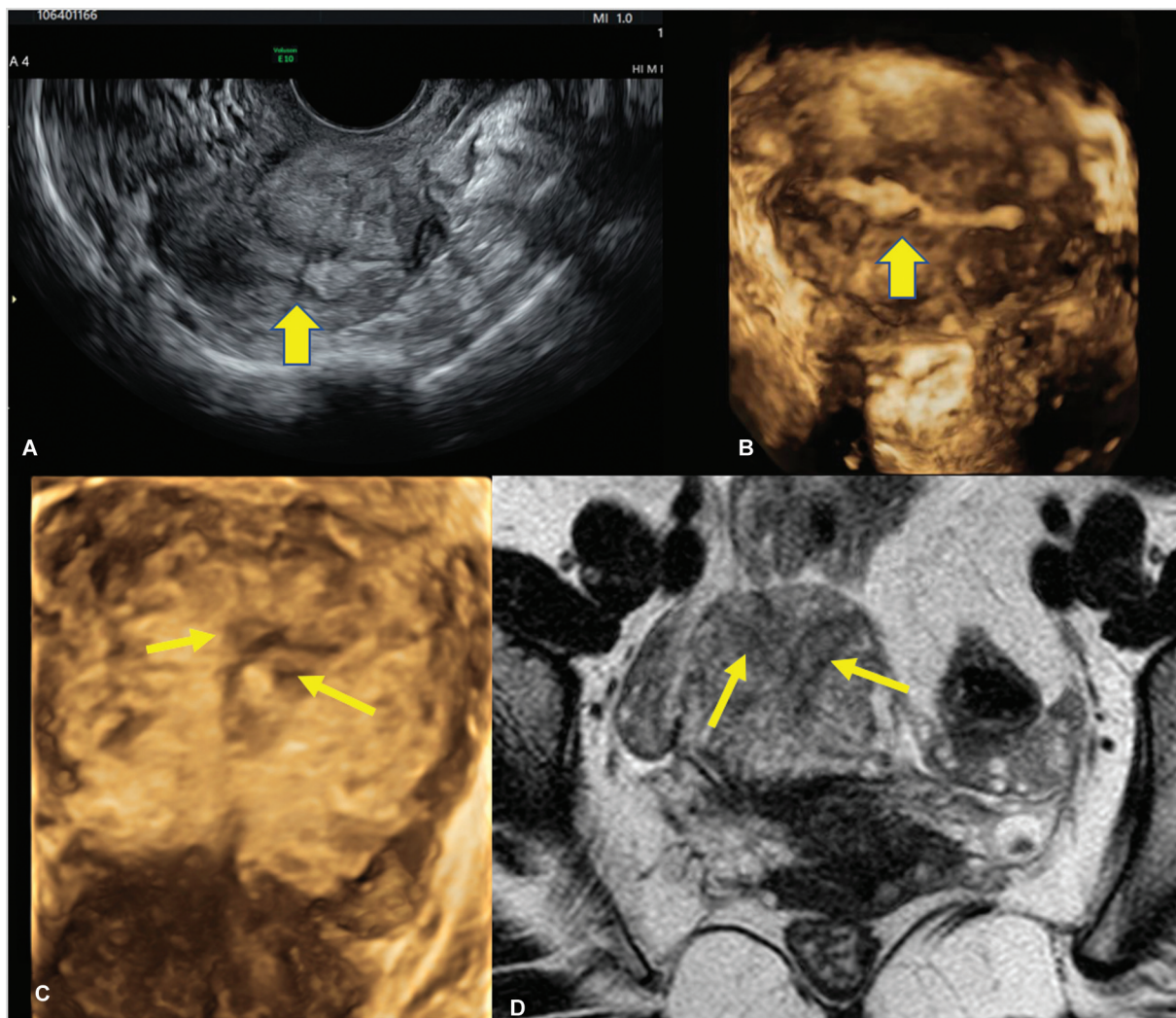
Fig. 7 Typical appearance of endometritis: (**A**) Ultrasonography (USG) image shows irregularly thickened endometrium with hypoechoic linear band (open arrows) traversing the endometrium - adhesion. (**B**) Three-dimensional (3D) USG image in the same patient shows irregular thickening of the endometrium with hypoechoic bands within - endometritis with synechiae. In a female with infertility (**C**) 3D USG images show the endometrial cavity splitting into two parts (arrows) in the fundus with irregular endometrium and loss of endomyometrial junction—pseudoseptate appearance. (**D**) T2-weighted (T2W) magnetic resonance imaging (MRI) image shows a pseudoseptate appearance of the uterus (arrows) with irregular endometrium and indistinct endomyometrial junction likely secondary to endometritis.

of calcification within the endometrium. Synechiae may be seen on US as focal areas of discontinuity disrupting the endometrium.[6] The visualization of synechiae within the endometrium is improved by using the technique of saline infusion sonography which distends the endometrial cavity with fluid and synechiae are seen as linear echogenic bridges within this fluid.[17] Synechiae are, however, not specific to tuberculosis and can occur secondary to any cause of PID or dilatation and curettage.[18]

Cross-Sectional Imaging (CT and MRI)

Cross-sectional imaging modalities like CT and MRI using contrast are excellent to demonstrate the extent of involvement of the female genital tract, peritoneal spread, as well as disseminated disease (►Table 3).

The most common finding is the presence of unilateral or bilateral multiloculated cystic or mixed solid cystic lesions showing peripheral rim enhancement as well as complete or incomplete enhancing septations within. The fallopian tubes can show thickened and enhancing walls indicating salpingitis. Distention of the coiled tubular structures in the adnexa distended with clear fluid (hydrosalpinx) or complex high-density fluid (pyosalpinx) may be seen on CT (►Fig. 8). In cases where the diagnosis is uncertain, a contrast-enhanced (CE) MRI is useful in differentiation. While hydrosalpinx shows intensely bright signal on T2-weighted images, it appears hypointense on T1-weighted images and does not show any diffusion restriction.[19] CE-MRI is also excellent in differentiating pyosalpinx and hematosalpinx. Pyosalpinx seen in association with tuberculosis appears hypointense

Table 3 Summary of imaging features of tuberculosis on cross-sectional imaging (CT and MRI)

Imaging features of tuberculosis on CT and MRI
Fallopian tubes:
Salpingitis – Thickened and enhancing of walls of fallopian tubes
Hydrosalpinx – Dilated tubular structures with T2 hyperintensity and peripheral enhancement
Pyosalpinx – Dilated fallopian tubes distended with hyperdense content, showing diffusion restriction
Ovaries:
Multilocular cystic lesions showing peripheral enhancement with complete and incomplete septations with central T2 hypointensity, diffusion restriction
Uterus:
Pyometra – endometrial cavity distended with heterogeneous content, shows diffusion restriction
Cervix:
Bulky
Associated findings:
Ascites
Peritoneal thickening
Peritoneal enhancement
Omental caking
Necrotic and conglomerated lymph nodes

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging.

on T1-weighted images and hyperintense on T2-weighted images; however, the high proteinaceous contents may manifest as bright signal on T1-weighted images and also shows postcontrast wall enhancement (►Fig. 9).
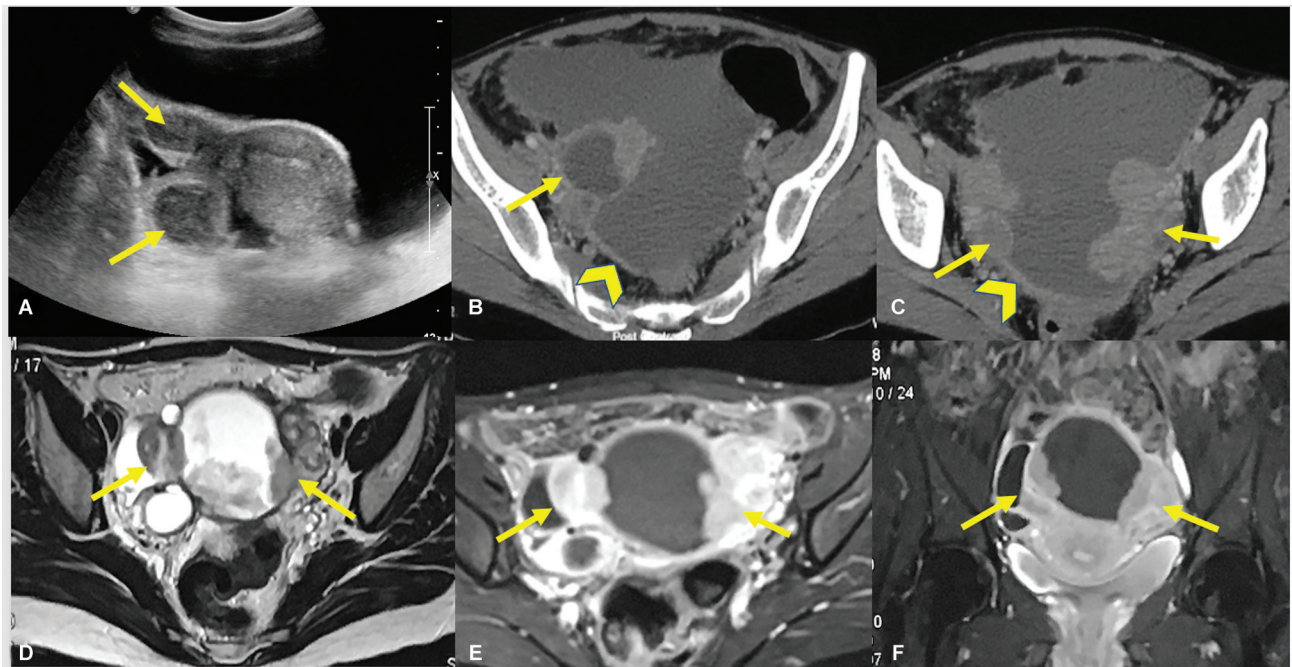
Fig. 8 Bilateral tubo-ovarian complexes of tubercular etiology: Ultrasound (US) spot (A) reveals bilateral adnexa to be bulky and mild fluid in the pouch of Douglas. Contrast-enhanced computed tomography (CECT) images (B, C) show heterogeneously enhancing bilateral tubo-ovarian complexes (arrows) with moderate ascites and peritoneal thickening (arrow heads). Contrast-enhanced magnetic resonance imaging (CE-MRI) images (D–F) show bilateral tubo-ovarian complexes, not seen separately from the ovary with the lesion on the left having T2 hypointense soft tissue nodule showing postcontrast enhancement.
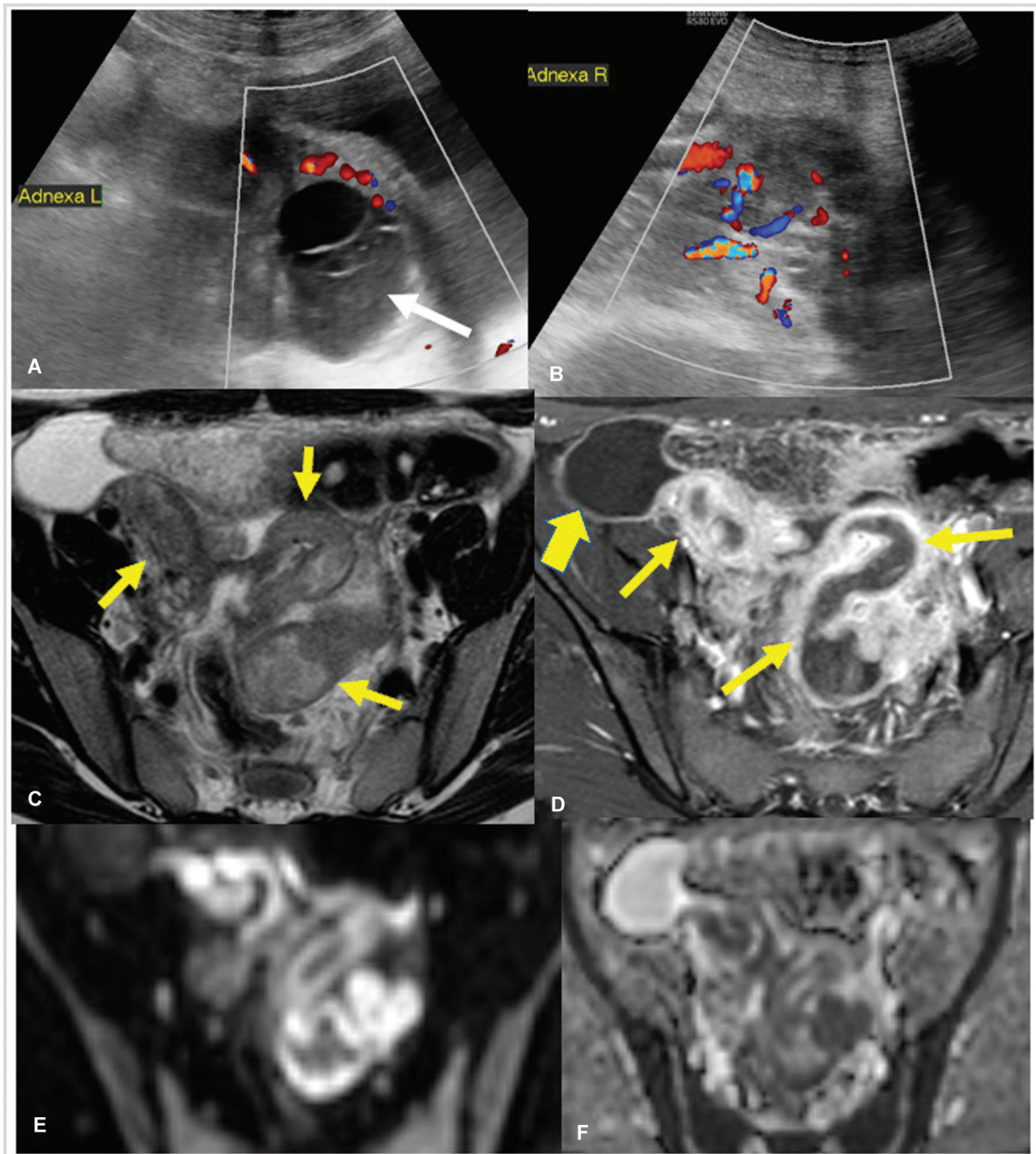
Fig. 9 Tubercular disease involving bilateral adnexa: (**A**) Ultrasonography (USG) with Doppler image of the left adnexa shows a smooth multilocular cystic lesion with peripheral vascularity (white arrows) and one of the compartments showing reticular pattern. (**B**) US shows the right ovary to be normal. (**C**) Axial T2-weighted (T2W) magnetic resonance imaging (MRI) image shows a multilocular cystic lesion in the left adnexa which is showing T2 intermediate signal intensity within and bilateral tubes are dilated (arrows) and filled with T2 intermediate signal intensity fluid. (**E**) Axial postcontrast T1W image shows thick peripheral enhancement along the walls of the tubes (arrows) and smooth enhancement along the peritoneum (open arrow). (**F**) Diffusion-weighted imaging (DWI) and (**G**) apparent diffusion coefficient (ADC) maps show diffusion restriction.

Hematosalpinx (seen in association with endometriosis), on the other hand, is usually very bright on T1-weighted fat-suppressed images and shows shading on T2-weighted images and does not show thick peripheral wall enhancement.[20]

Surrounding areas of pelvic fat stranding and haziness and thickening of the uterosacral ligaments are associated findings, which however is not specific and can be seen in any gastrointestinal, genitourinary, or gynecological condi-tion.[21] The differentiation with PID caused by organisms like *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Myco-plasma genitalium*, and Gram-negative bacteria is of impor-tance. Tubal involvement is seen in both diseases but obstruction is more commonly seen with PID (►**Fig. 10**).[22] Since tubal involvement in PID occurs via ascending route in the genital tract, associated endometritis and cervicitis tend to be more commonly seen in associa-tion with PID.[23]
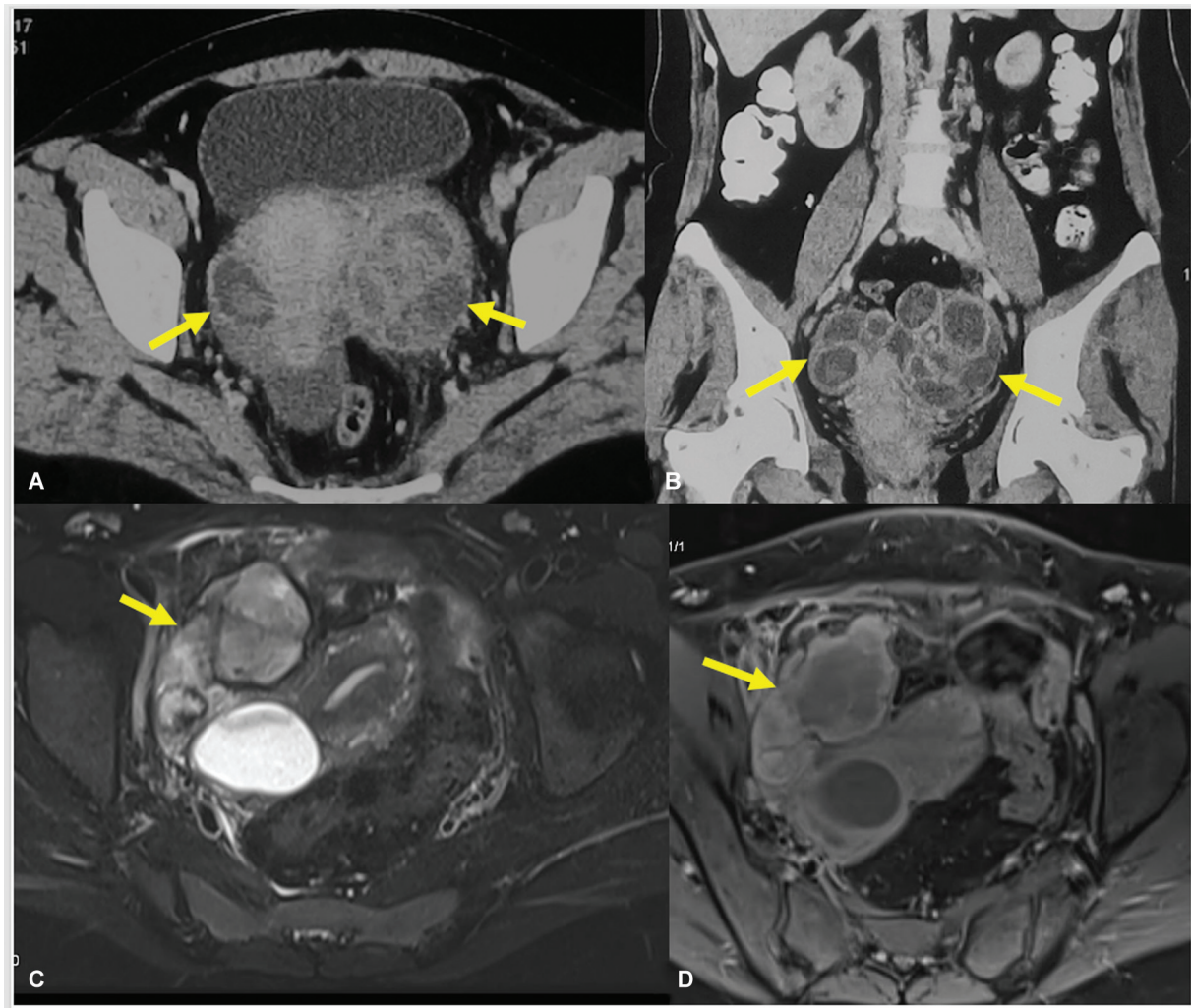
Fig. 10 Pelvic inflammatory disease mimicking tuberculosis: Contrast-enhanced computed tomography (CECT) (**A**) axial and (**B**) coronal images of the pelvis depict bilateral complex adnexal masses (arrows) with thick peripherally enhancing walls and hyperdense debris/content within. (**C**) Axial T2-weighted (T2W) image of the pelvis in a separate patient depicts a complex right adnexal mass with T2 hypointense content—likely debris. (**D**) Axial postcontrast T1W image shows thick irregular peripheral rim enhancement along the wall (arrows). In both cases aspiration of contents revealed Gram-positive and Gram-negative bacilli.

Tubo-ovarian masses associated with tuberculosis appear as bilateral multilocular cystic masses with or without solid appearing component. These may show peripheral enhancement and high-density fluid within.[24] Calcification and peritoneal involvement in association with the tubo-ovarian masses is more common with tuberculosis than with PID.[24] On MRI, the tubo-ovarian abscesses caused by tuberculosis show central T2 hyperintensity and few T2 hypointense septations or strands. On diffusion-weighted images there is central diffusion restriction and intense enhancement of the rim and the septations on the postcontrast images. The walls of tubercular tubo-ovarian masses are more serrated and irregularly nodular as compared to PID abscesses, in which there is uniform wall thickening.[24] Tubo-ovarian masses are frequently accompanied by ascites, peritoneal thickening, omental nodularity, and mesenteric infiltrations. Loculated fluid collections with peripherally enhancing walls and enhancing septations within are often associated findings and suggest a tubercular etiology. Endometriosis is another close differential diagnosis and distinction may be difficult on CT alone. However, MRI is an excellent modality for differentiation and endometriomas show hyperintense signal on T1-weighted fat-suppressed images caused by the high concentration of paramagnetic hemoglobin in blood breakdown products.[25] The other classical feature of endometriomas is "T2 shading" which is a drop in the signal intensity on T2-weighted images.[26,27] In addition, genital tuberculosis and endometriosis are important causes of infertility which may coexist and cause dilemma in the diagnosis and management of such patients.[28] Clinical manifestation of "frozen pelvis" can happen in both situations. Imaging would reveal bilateral multilocular adnexal masses with adhesions to the uterus, bowel, and pelvic side walls. MRI can be problem solving in these situations by identifying the typical imaging appearance of endometriosis. In addition, the presence of necrotic lymph nodes, ascites, and peritoneal disease favors tuberculosis in these situations.

Irregular contour of the uterine cavity can be identified on three-dimensional ultrasonography (USG) and T2-weighted
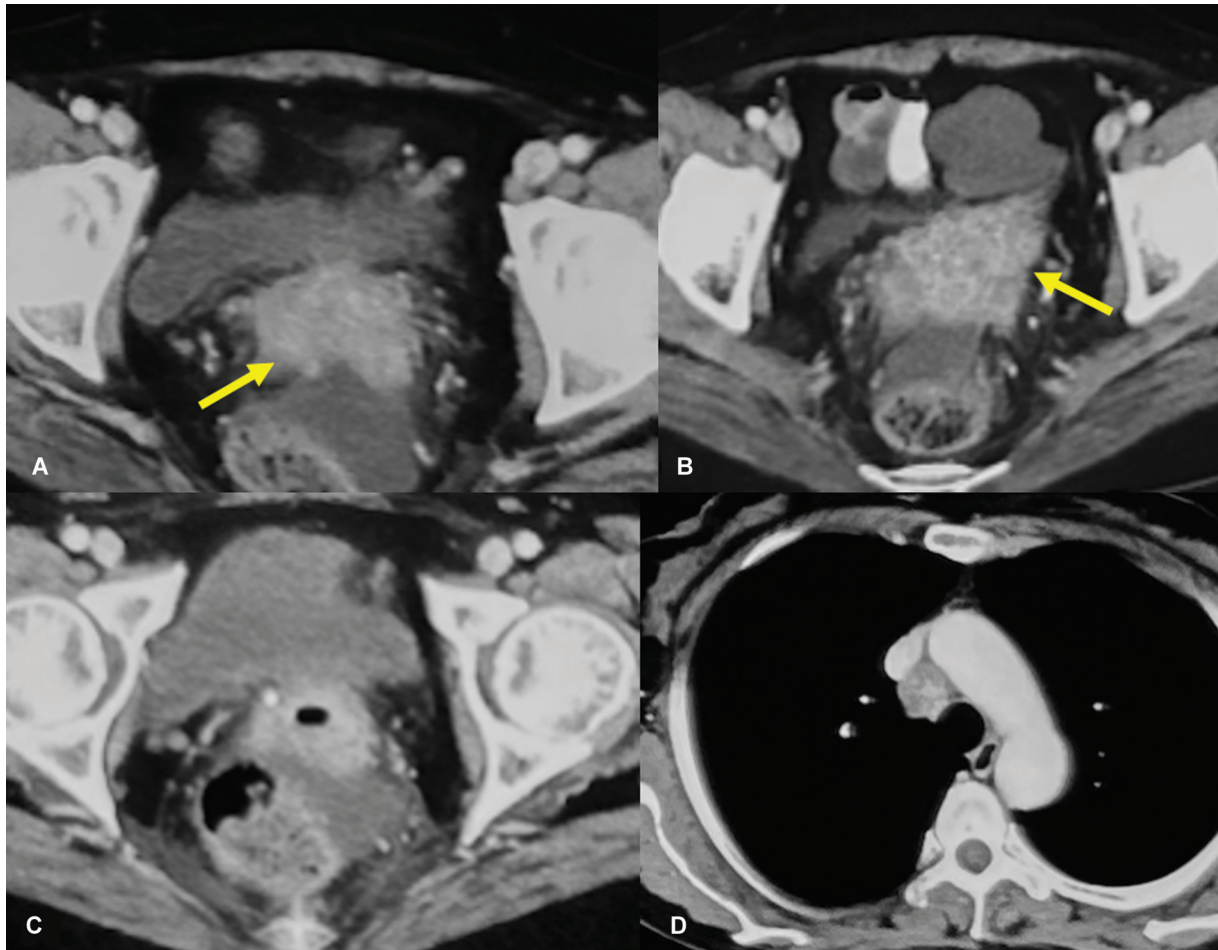
Fig. 11 Tuberculosis involving the cervix mimicking cervical cancer: Axial contrast-enhanced computed tomography (CECT) images (**A**–**C**) at the level of the cervix show a heterogeneously enhancing mass-like lesion involving the cervix (arrows) with mild ascites and a possibility of cervical cancer was given for the same. (**D**) Axial CECT images of the chest showed a necrotic lymph node in the pretracheal location. Biopsy done from the cervical mass revealed caseating granulomas suggesting tuberculosis.

images. The endometrial cavity may be distended with pus and on imaging the cavity shows a peripherally enhancing fluid collection (pyometra).[29]

Tuberculosis involving the cervix is an uncommon entity and may mimic the more common cervical cancer on imaging.[30,31] CT may show a bulky cervix with postcontrast enhancement within the endocervical canal (►**Fig. 11**). Ulcers within the cervix and polypoidal lesions both may be seen in the spectrum of tuberculosis which are radiologically indistinguishable from cervical cancer. Sampling with histopathological diagnosis is essential in making a final diagnosis.

Vulvovaginal Tuberculosis

Tubercular involvement of the vagina and vulva is extremely rare and involvement usually occurs by direct extension of disease from the endometrium or the tubes. Rarely, however, disease transmission can occur from semen of an infected partner. Clinical presentation may be in the form of a hypertrophic ulcerated lesion in the vagina/vulva or multiple sinus tracts and exclusion of malignancy by biopsy is necessary.

## Associated Features Favoring Female Genital Tract Tuberculosis

Lymphadenopathy
There can be associated necrotic and conglomerated pelvic and abdominal lymph nodes which may help clinch the diagnosis of pelvic tuberculosis.

Ascites and Peritoneal Enhancement
A common associated finding is the presence of high-density ascites (mean attenuation > 18 HU). The imaging findings of peritoneal involvement include lymphadenopathy, ascites, thickening and nodularity of the peritoneal surface, mesentery, omentum, and the bowel serosa. The presence of ascites and peritoneal enhancement are not specific to tuberculosis and may also be seen in cases of peritoneal carcinomatosis. The most useful CT finding which can help differentiate peritoneal tuberculosis from peritoneal carcinomatosis is the type of peritoneal thickening. Tubercular peritonitis has smooth minimal thickening whereas peritoneal carcinomatosis shows nodular deposits and thick, irregular peritoneal enhancement (►**Fig. 12**).[32,33] Scalloping of the liver surface if present favors a
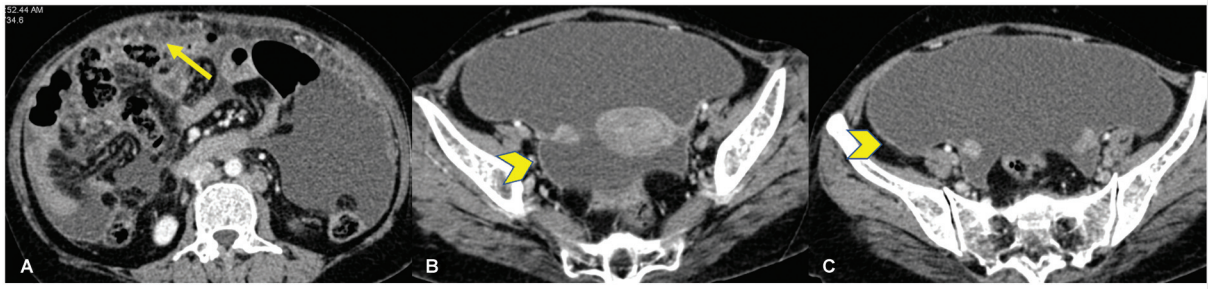
Fig. 12 Peritoneal tuberculosis mimicking peritoneal carcinomatosis: Axial contrast-enhanced computed tomography (CECT) images of the abdomen (**A–C**) show omental nodularity (arrow) moderate ascites and peritoneal thickening and enhancement (arrow heads). The differentials kept were peritoneal tuberculosis and disseminated ovarian malignancy with peritoneal spread. Ascitic fluid sampling revealed raised adenosine deaminase (ADA) levels suggesting a diagnosis of peritoneal tuberculosis.
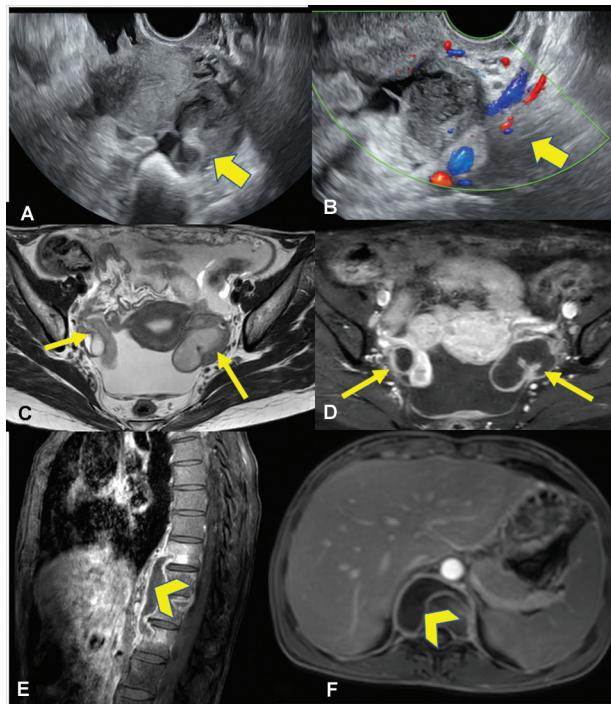

Fig. 13 Disseminated tuberculosis: In a young female who presented with complaints of lower abdominal pain and dyspareunia ultrasonography (USG) spots (**A**, **B**) show multilocular cystic lesions with internal echoes within in bilateral adnexa (arrows) with associated moderate pelvic ascites. (**C**) Axial T2-weighted magnetic resonance (MR) image shows multilocular convoluted cystic lesions in bilateral adnexa which are mildly hyperintense (arrows). (**D**) Postcontrast T1-weighted (T1W) image shows peripheral rim enhancement along the tubular lesions bilaterally and along the peritoneum. (**E**) Sagittal and (**F**) axial postcontrast image of the dorsal spine shows spondylodiscitis D10-L1 with associated peripheral rim enhancing pre- and paravertebral collection (arrow heads).

diagnosis of peritoneal carcinomatosis.[34] There is no significant difference with respect to the presence of lymphadenopathy in favoring one diagnosis over the other.[32] The presence of adnexal masses, peritoneal thickening and enhancement, omental involvement, and ascites can be found in tuberculosis, PID, or ovarian malignancies. While CA 125 can be raised in a variety of pathologies like tuberculosis involving genital tract, endometriosis, peritonitis, ovarian hyperstimulation syndrome, and ovarian malignancies, it is rare for pelvic tuberculosis to present with very high serum CA 125 (> 1000 U/mL) levels and therefore such high values should point to a diagnosis of ovarian carcinoma.[35,36]

Fistulous Disease

As a sequelae to tuberculosis there may be communication between the gastrointestinal tract and female adnexal viscera rarely. These include formation of fistulous communications between the fallopian tube and rectum, sigmoid, appendix, caecum, and ileum. The etiology is thought to be tubal occlusion by inflammatory infiltrate resulting in fistulous communications at other locations. The presentation may be with lower abdominal pain, passage of flatus per vagina, sepsis, and diarrhea, though incidental detection in patients being worked up for infertility is not uncommon. The diagnostic findings on HSG are contrast opacifying the
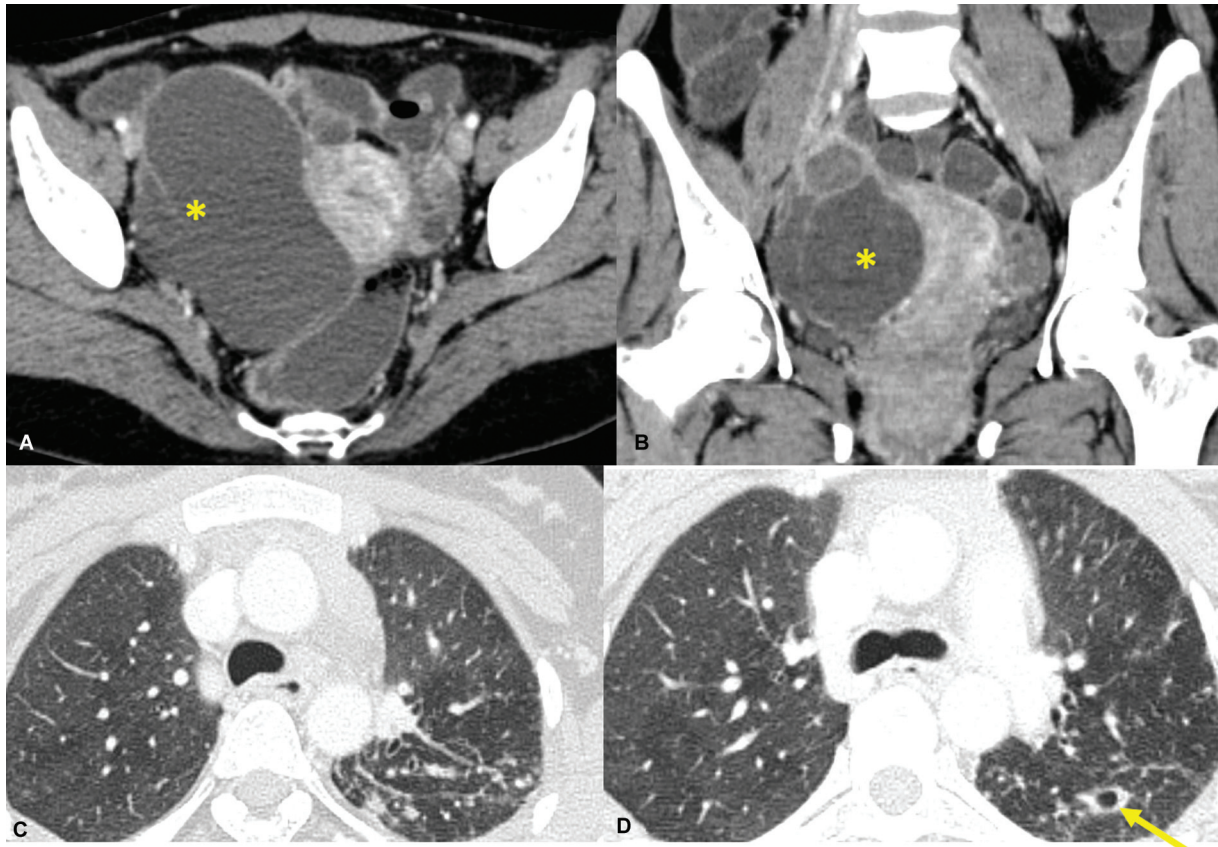
Fig. 14 Disseminated tuberculosis: (**A**) Axial contrast-enhanced computed tomography (CECT) image of the pelvis shows dilated tubular structure in the right adnexa with thin partial septa within—hydrosalpinx (asterisk). (**B**) Coronal image depicts the findings better. (**C**, **D**) Axial image of the chest in lung window shows centrilobular nodules and a small thin-walled cavity (arrow) in the left upper lobe.

bowel lumen, which may also demonstrate progressive passage along the distal bowel on delayed films. The presence of multiple sinus tracts or fistulae as evident on cross-sectional imaging may suggest possible tubercular disease.

Pulmonary tuberculosis, tubercular spondylitis, and ileocecal tuberculosis are common forms of disease involvement by tuberculosis which may be seen coexisting with genital tuberculosis during cross-sectional imaging of chest and abdomen (►**Figs. 13** and **14**).

Conclusion

Female genital tuberculosis is often underdiagnosed and unrecognized but contributes to significant morbidity, representing an important cause of infertility in women. Radiologists should be aware of the myriad and classic imaging features of tuberculosis on various modalities like HSG, USG, CT, and MRI. Knowledge of the key differentiating features of the close imaging mimics of female genital tuberculosis like PID, endometriosis, and ovarian malignancy can lead to an accurate diagnosis and timely management.

Authors' Contributions
S.G. was responsible for writing the draft, revising, and finalizing the manuscript. S.M. contributed to the concept,

revision, and approval. A.A. also worked on writing the draft, revising, and finalizing the manuscript.

Conflict of interest
None declared.

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