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Seminars in ULTRASOUND CT and MRI

Nonovarian Mimics of Ovarian Malignancy

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Once a pelvic mass is identified on an ultrasound examination, the first step in the differential diagnostic work up is to determine its origin. Most lateral pelvic masses in women are ovarian in origin, and the distinction between ovarian and nonovarian mimics of ovarian cancer is critical for appropriate clinical and surgical management. Adnexal masses detected on ultrasound can be further characterized by magnetic resonance imaging (MRI) when needed. Superior contrast resolution, multiplanar imaging, characteristic signal intensity of common pathology such as dermoid tumors or endometriomas allows one to accurately evaluate adnexal tumors with supplemental use of MRI. Commonly encountered extraovarian abnormalities that mimic ovarian malignancies are categorized as being either predominantly cystic or solid. The common causes of such extraovarian lesions that mimic ovarian pathology include fallopian tube diseases, paroaovarian cysts, peritoneal inclusion cysts, and a pedunculated or a broad ligament fibroid. Less common causes of cystic and solid nonovarian mimics of ovarian malignancy include mucocele of the appendix, lymphocele, spinal meningeal cysts, extraovarian endometriomas, extraovarian fibrothecomas, and gastrointestinal stromal tumors (Table 1). Identifying a normal appearing ovary is the key in distinguishing an extraovarian pelvic mass from an ovarian tumor. This becomes particularly challenging in postmenopausal women with atrophic ovaries. In this scenario, MRI comes into use by identifying small atrophic ovaries more often than ultrasound is able to. Extraovarian lesions typically displace the pelvic sidewall vasculature medially, ureters tend to be compressed, encased or medially displaced, enhancement matches pelvic arteries and may be associated with engorged mesenteric vessels compared to gonadal vessel engorgement seen with ovarian tumors.

Semin Ultrasound CT MRI 40:319-331 © 2019 Elsevier Inc. All rights reserved.

Cystic Extraovarian Mass

Fallopian Tube Pathology Mimicking Ovarian Tumors

Primary fallopian tube carcinoma (PFTC) is a rare gynecological tumor accounting for 0.14%-1.8% of gynecological malignancies. It commonly occurs in older women between 40 and 65 years with a mean age of 55 years. Prognosis is poor with a 5-yearr survival ranging from 22% to 57%. When a patient presents at an earlier stage due to symptoms the prognosis is better. Treatment is similar to epithelial ovarian cancer (EOC) with a prognosis worse than epithelial ovarian cancer. There is an association with chronic tubal inflammation, tuberculous salpingitis, tubal endometriosis, and infertility.[1,2] True incidence may be underestimated due to incorrect diagnosis of a serous epithelial cancer of the ovary. In England and Wales 40 cases of PFTC and 4500 cases of epithelial ovarian cancers are reported annually.[3] In a cohort of 22,000 women undergoing screening a much higher ratio of PFTC to EOC was observed, the ratio of PFTC to ovarian cancer was found to be 10 times higher than predicted by national cancer incidence figures.[4] Lymphatic spread is more common with PFTC compared to EOC. Vaginal bleeding is seen in 50%-60% of patients, a colicky or dull abdominal pain in 30%-49% of patients and an abdominal mass in 60% of cases, ascites in 15% of patients.[3] In one series 62% of patients with PFTC were asymptomatic (Table 1).[5]

Imaging Features of PFTC

These tumors are most commonly solid (67%). Some are multilocular solid (18%) and unilocular solid (13%) and uncommonly unilocular (3%). Most tumors show moderate to high vascularity. Typical sonographic features include an oblong

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https://doi.org/10.1053/j.sult.2019.04.003

Table 1 Nonovarian Mimics of Ovarian Malignancy

Cystic Nonovarian Masses	Solid Nonovarian Masses
Fallopian tube abnormalities	Broad ligament fibroid
• Fallopian tube carcinoma	Chronic hematoma
• Tuboovarian complex of PID	Extraovarian fibrothecoma
• Hematosalpinx	Gastrointestinal Stromal Tumor (GIST)
• Chronic tubal pregnancy	Pelvic Metastasis
Extraovarian endometrioma	
Peritoneal inclusion cyst	
Paraovarian cyst	
Bowel related	
• Mucocele of the appendix	
• Rectal Duplication Cyst	
Extra peritoneal	
• Spinal meningeal cyst	
• Lymphocele	

solid mass (58%), a sausage shaped cystic structure with solid tissue protruding into the cystic lesion (18%), and a large solid component filling part of the cyst cavity (21%) (Fig. 1). In a majority of cases (51%), normal ovarian tissue is identified adjacent to the fallopian tube tumor.[5] Three-dimensional (3D) ultrasound and power Doppler have been shown to be useful. A sausage shaped cystic mass with papillary projections was shown on 3D ultrasound in all 5 cases of PFTC compared to 3 cases seen on 2-dimensional ultrasound. Bilaterality was also correctly shown on a 3-dimensional ultrasound when not so with 2D transvaginal ultrasound. 3D power Doppler was able to characterize malignant tumor vessels showing arteriovenous shunts, microaneurysms, and tumoral lakes, and dichotomous branching in all 5 cases of PFTC. Spectral Doppler typically shows a low impendence flow pattern.[6] The fallopian tube in PFTC is patient at least at one end with characteristic gradual distension causing colicky pain and periodic decompression resulting from emptying of the fluid from either end leading to a characteristic shrinkage of the pelvic mass.[7]

Hematosalpinx refers to distension of the fallopian tube by blood products. A hematosalpinx may be caused by tubal endometriosis, chronic tubal pregnancy, tubal torsion, PFTC, or trauma. The underlying cause can often be determined based on clinical history and imaging appearance. On ultrasound, a tubular cystic structure separate from the ovary is seen with low level internal echoes characteristic of blood (Fig. 2). Distinction from a pyosalpinx may be difficult on imaging since both conditions will show a fallopian tube dilated by fluid containing low level echoes with or without wall thickening.

Computed tomography (CT) imaging will demonstrate high density contents and on T1-weighted magnetic resonance imaging (MRI) images high signal intensity is characteristic. Tubal endometriosis affects about 6% of patients with endometriosis, serosal or subserosal endometriosis are more common and lead to fibrosis and scarring of the tubes. The intraluminal

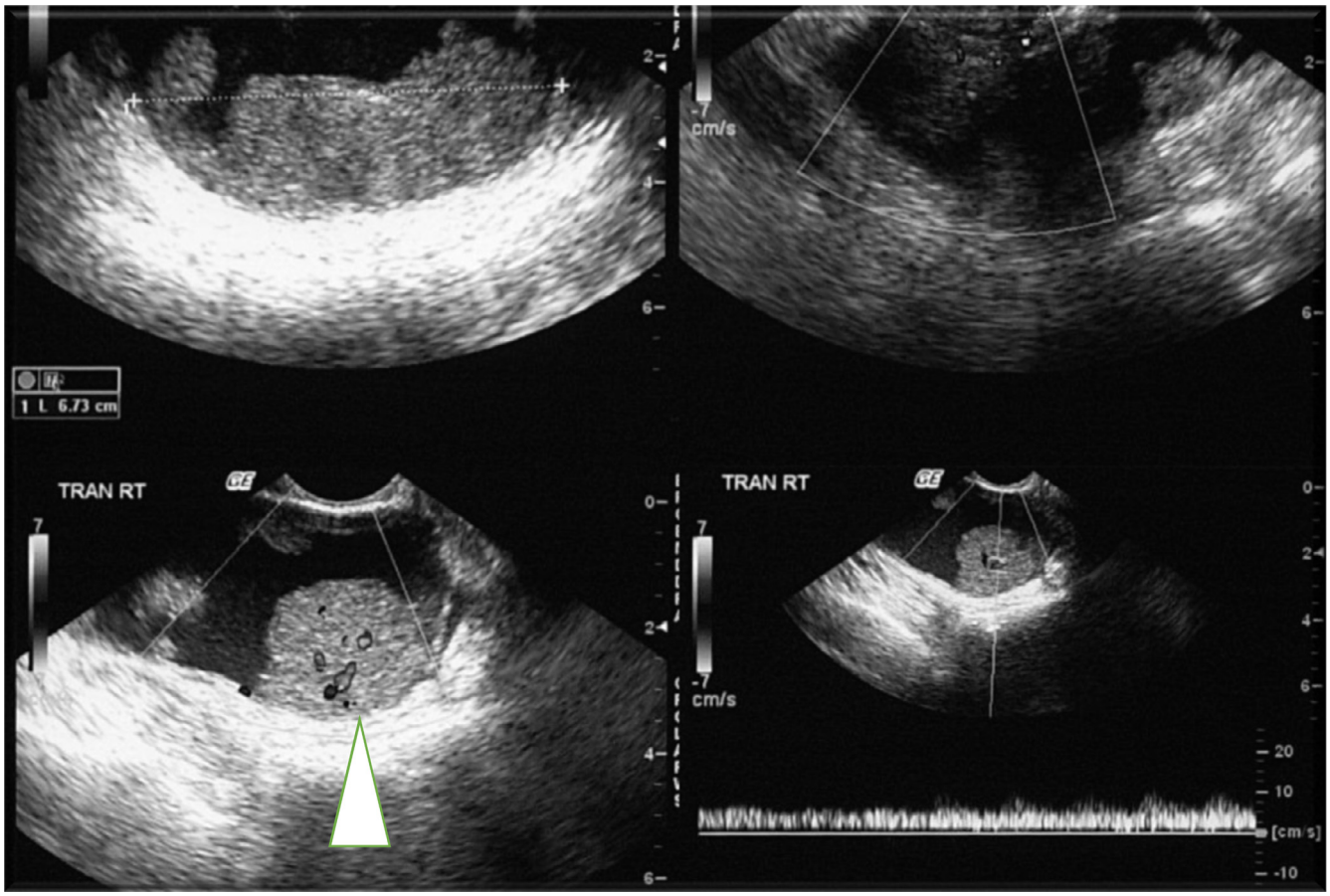

Figure 1 Fallopian tube carcinoma.

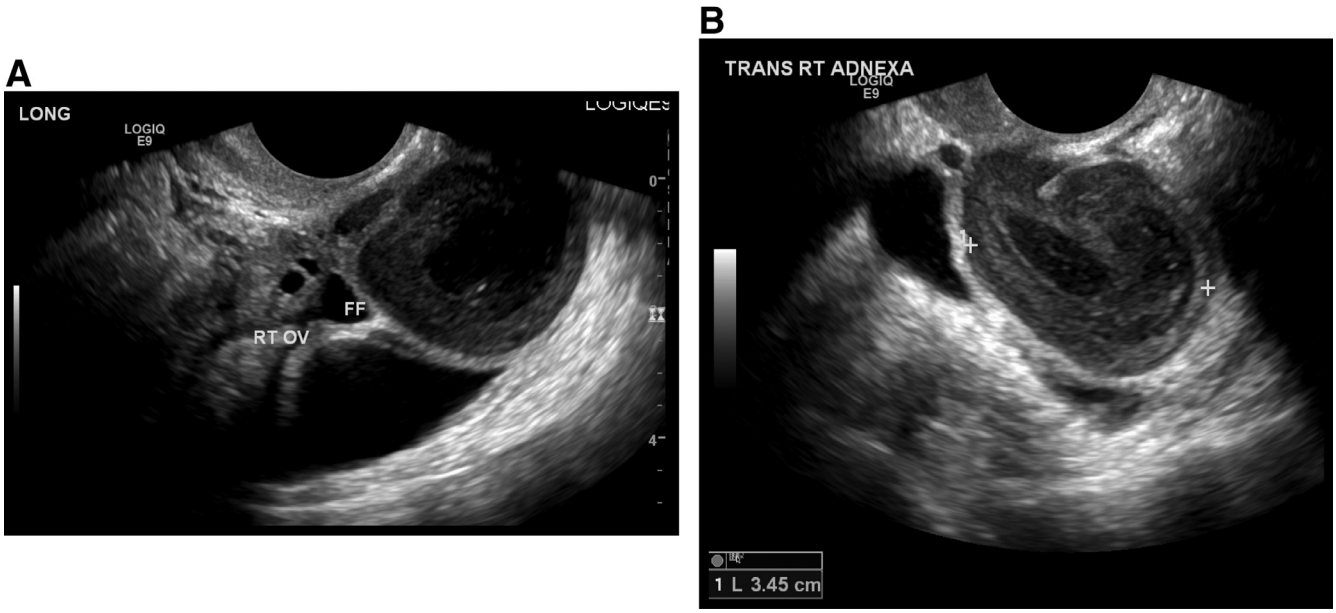

Figure 2 Hematosalpinx.

endometriosis is endoluminal implantation of endometrial tissue, this leads to formation of a cystic tubular extraovarian mass resulting from bleeding during cycles. There is progressive distension of the fallopian tube. T2 shading seen in endometrioma is not typically seen in a hematosalpinx.[8,9]

Chronic tubal pregnancy is rare and results from gradual and protracted destruction of the wall of the fallopian tube associated with slow and recurrent episodes of bleeding. This in turn leads to formation of an adnexal mass. Pathologically, there is a hematosalpinx, or an inflammatory mass consisting of blood clots, organized hematoma, and surrounding adhesions (Fig. 3). Patients present with vague abdominal pain, vaginal bleeding, amenorrhea, and pyrexia. The differential diagnosis would include endometriosis and pelvic inflammatory disease (PID).[9] Progressive enlargement after initial identification on transvaginal sonogram has been described.[10] Prominent vascular flow may be present with areas of hemorrhage, human chorionic gonadotropin levels may be low or normal.[11] When human chorionic gonadotropin levels are elevated in a patient with a large adnexal mass a malignant ovarian germ cell tumor is in the differential diagnosis. The latter may also be associated with raised Alpha-fetoprotein and lactic acid dehydrogenase levels.[12]

Chronic tubo-ovarian abscesses are often misclassified by mathematical models used to assess risk of malignancy in an adnexal tumor because of their solid character and high vascularity. A significant number of masses difficult to classify as benign or malignant turn out to be chronic tubo-ovarian abscesses.[13,14] In the setting of a complex adnexal mass caused by chronic PID, the tubo-ovarian complex may be mistaken for ovarian malignancy when the clinical presentation does not align with infection. In such cases, superior contrast resolution of MRI may help in identifying a normal ovary, diagnosing pyosalpinx or hematosalpinx and correctly identifying the tubular nature of the distended abnormal fallopian tube.[15] Tubo-ovarian abscess is a well-known sequela of acute or chronic salpingitis (Fig. 4). In a small number of patients, Tubo-ovarian inflammatory masses can compress or rupture into adjacent organs and simulate an infiltrating malignancy, this may lead to unnecessary debulking surgery.[16] Rare cause of chronic PID masquerading as ovarian malignancy is peritoneal tuberculosis.

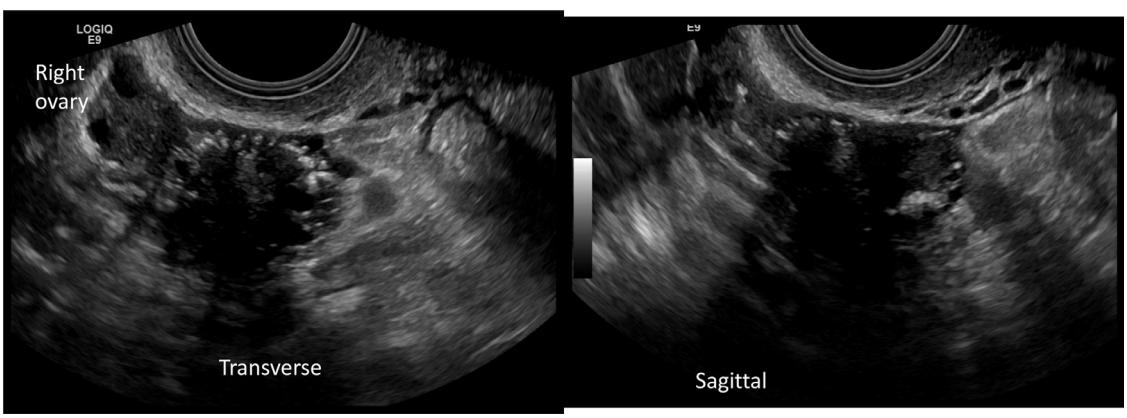

Figure 3 Chronic Tubal pregnancy.

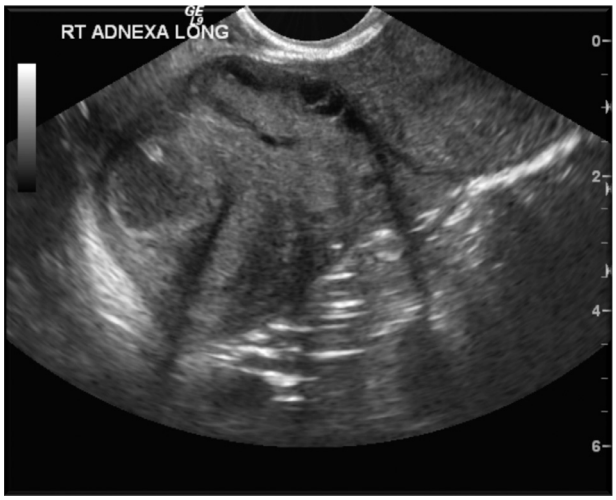

Figure 4 Chronic Tuboovarian abscess.

In one series of 113 extraovarian abnormalities, 42 (37.7%) were proven to be tuberculosis (TB). There can be an overlap in the clinical presentation of ovarian malignancy and TB, with abdominal pain, ascites, abdominal and pelvic masses, and elevated CA-125 being commonly associated with both these conditions. On imaging, 95% of patients had ascites, 81% had a pelvic mass and 11.9% had omental caking. In this series, women with TB were, however, much younger than women with ovarian cancer.[17] PID caused by actinomycotic infection usually in women with an IUD can also present as a large complex adnexal mass that can mimic ovarian malignancy.[17]

Chronic hydrosalpinx results from blockage of the fimbrial end of the fallopian tube usually secondary to PID or endometriosis. A tubular cystic structure folded on itself with intraluminal projections from endosalpingeal folds giving the fluid filled structure a cogwheel appearance. Diametrically opposed narrowing of the distended tube gives a waist sign typical of a hydrosalpinx (Fig. 5).[9] Atypical appearance of the hydrosalpinx may simulate a multiloculated cystic mass with papillary projections leading to an erroneous diagnosis of a borderline ovarian malignancy particularly in postmenopausal women with atrophic ovaries.

Extraovarian Endometrioma

Endometriomas or chocolate cysts are hemorrhagic endometriotic cysts that are typically seen in the ovary. A unilocular cyst with compact internal echoes and a thick wall, avascular on color Doppler is seen separate from the ovary (Fig. 6). Extraovarian endometriomas can mimic ovarian malignancy and can present as a unilocular cystic mass with papillary projections and or solid components.[18] They can demonstrate vascular flow if chronic and decidualized, CA-125 can be elevated. A diagnosis of endometrioma can be challenging on ultrasound in atypical cases.[19] Clinical symptoms of pelvic pain, dysmenorrhea, and dyspareunia are commonly associated with an endometrioma. MRI is accurate at diagnosing an endometrioma with a sensitivity and specificity exceeding 90%.[20] MRI signal characteristics depends on the age of the hemorrhage, typically there is a high signal intensity on the T-1 weighted image and low signal intensity on the T2-weighted imaging sequence and no enhancement on the postcontrast images.[20] A multilocular cystic mass with thick septations may simulate an ovarian neoplasm.[18] Pain is a feature associated with endometrioma but may also be attributed to torsion of an ovarian tumor.

Peritoneal Inclusion Cysts

Peritoneal inclusion cyst is also referred to as entrapment ovarian cyst or peritoneal pseudocyst. Fluid released by the ovary during rupture of a follicle is believed to progressively accumulate around the ovary trapped by adhesions (Figs. 7 and 8).[9,21] This is a non-neoplastic entity that appears as a multiloculated cyst surrounding the ovary. The ovary particularly when not containing follicles can be mistaken for a solid component in a multilocular cystic mass. This can lead to a mistaken diagnosis of an ovarian neoplasm resulting in unnecessary surgical intervention. Invagination of surrounding structures may be associated giving these pseudocysts an irregular shape. True ovarian neoplasms tend to have thicker walls and do not demonstrate invaginations by adjacent

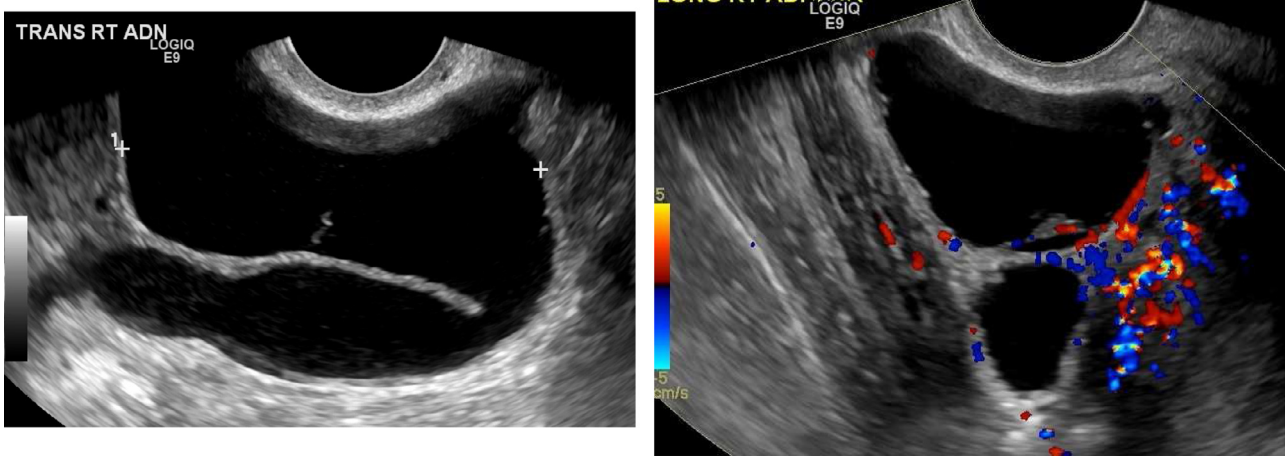

Figure 5 Hydrosalpinx.

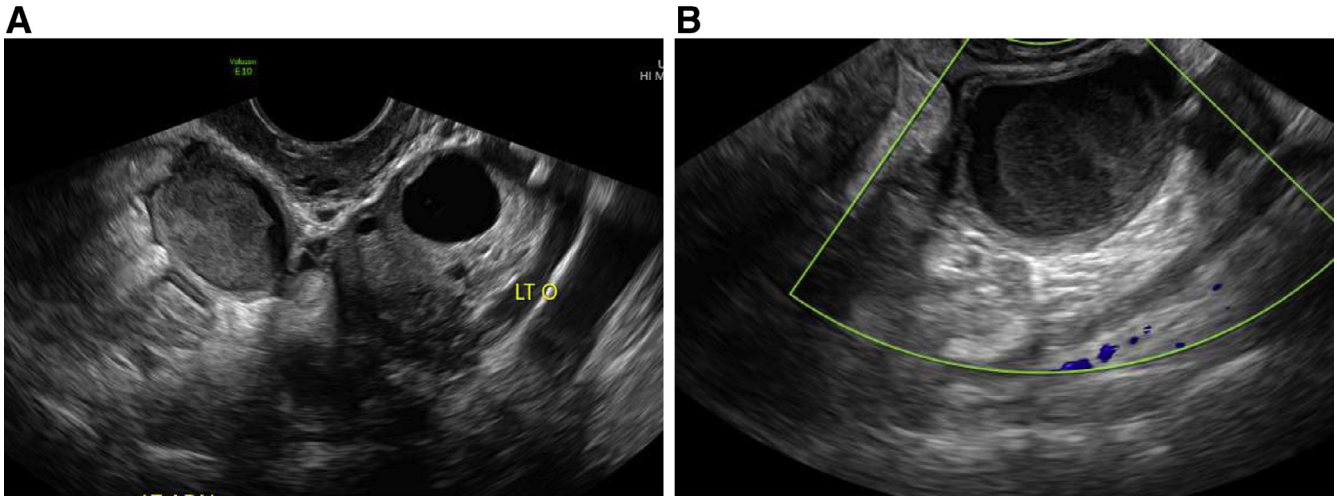

Figure 6 Extraovarian endometrioma.

structures.[21] Peritoneal inclusion cysts are seen in premenopausal women with active ovaries. The underlying causes include pelvic adhesions from prior surgery, endometriosis, or PID. This entity is often asymptomatic. The diagnostic feature is identification of a normal sized ovary entrapped within cystic locules, the entrapped ovary may be located centrally or eccentrically within the peritoneal pseudocyst. Cyst walls may demonstrate vascular flow with a low

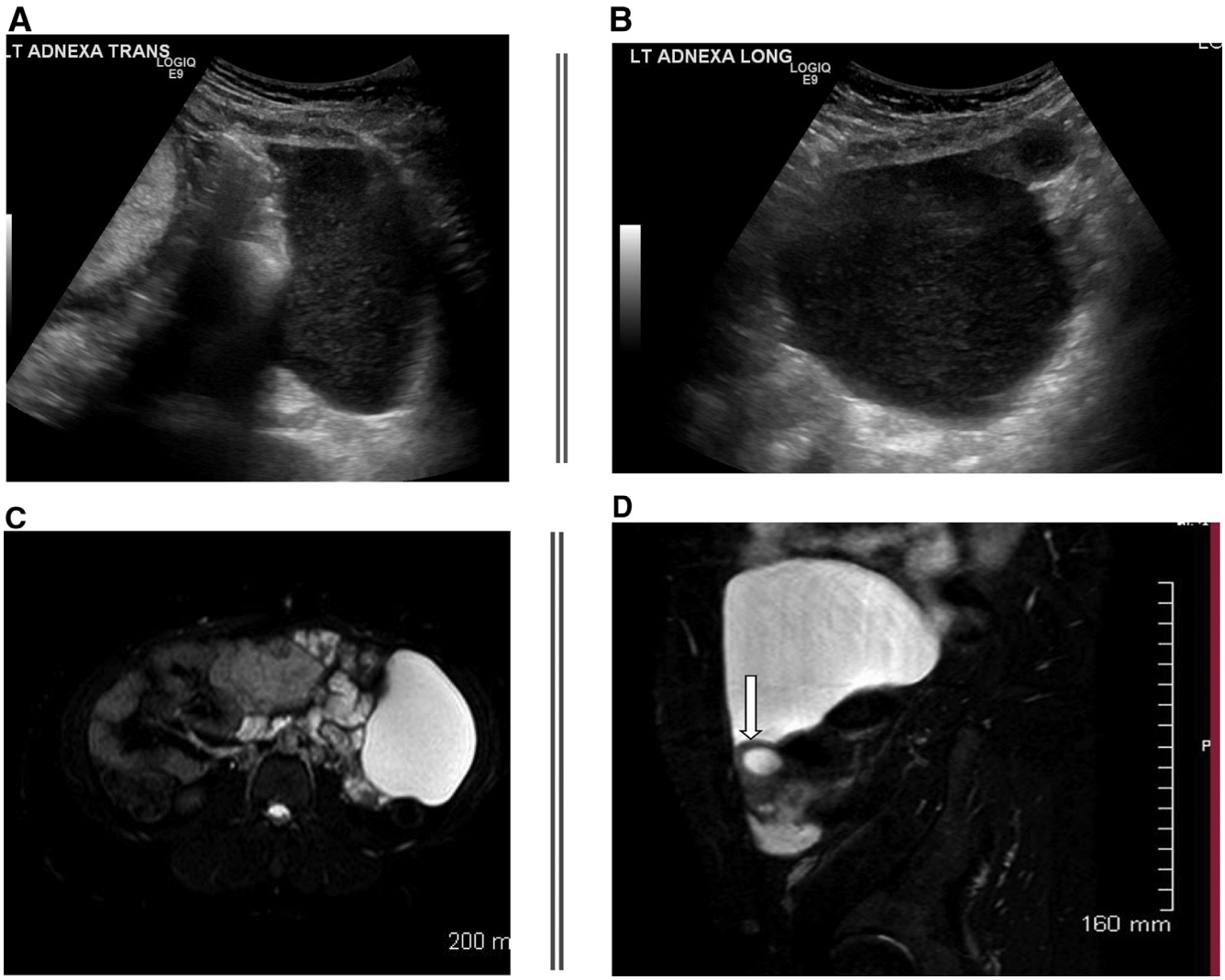

Figure 7 Peritoneal inclusion cysts.

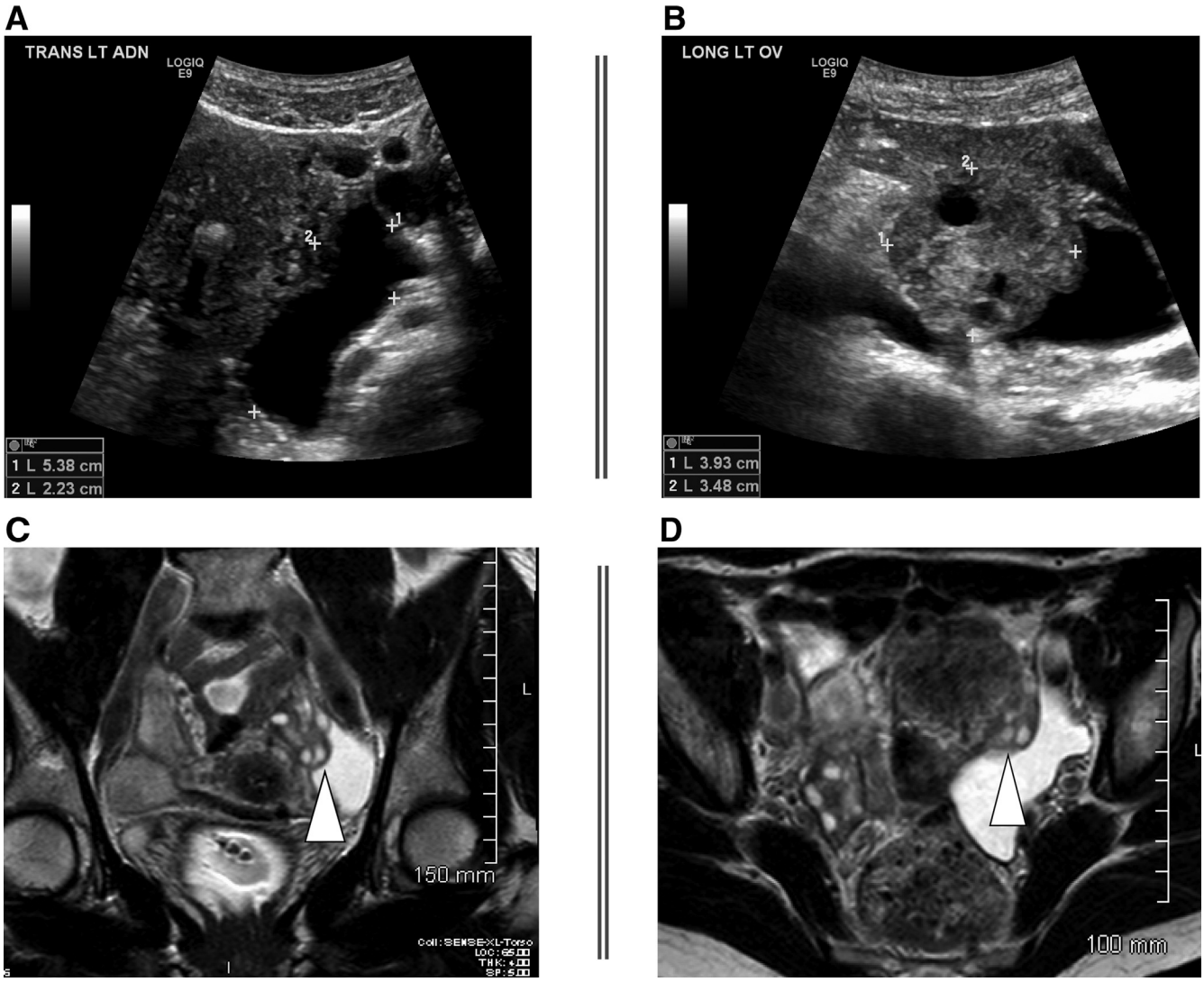

Figure 8 Peritoneal inclusion cyst.

resistance pattern on spectral Doppler interrogation. Hemorrhage within the cyst may lead to characteristic appearance on ultrasound and MRI.[9]

Paraovarian Cysts

Paraovarian cysts represent 10%-20% of adnexal cysts.[9,22-25] Paraovarian cysts arise from the superior border of the mesosalpinx. They are separate from the ovary, are most commonly seen in the third and fourth decade, an average size of 8cm has been reported.[22] These cysts are typically unilocular and seen separate from the ovary (Fig. 9). Paraovarian cysts can be misdiagnosed as ovarian cysts.[23] These cysts may be multilocular and large, and when avascular and without solid components or papillary projections are usually benign serous cysts (Fig. 10). Predictors for malignancy are size greater than 5cm, internal papillary excrescences and occurrence in reproductive age women. On MRI these cysts have thin nonenhancing walls and contain

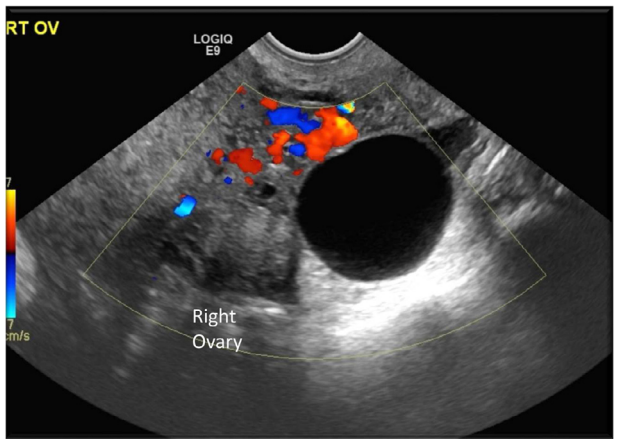

Figure 9 Paraovarian cyst.

low T1 intensity and high T2 signal intensity. Variable signal intensity is seen when there is hemorrhage. Presence of enhancing soft tissue component is suggestive of possible malignancy.[20]

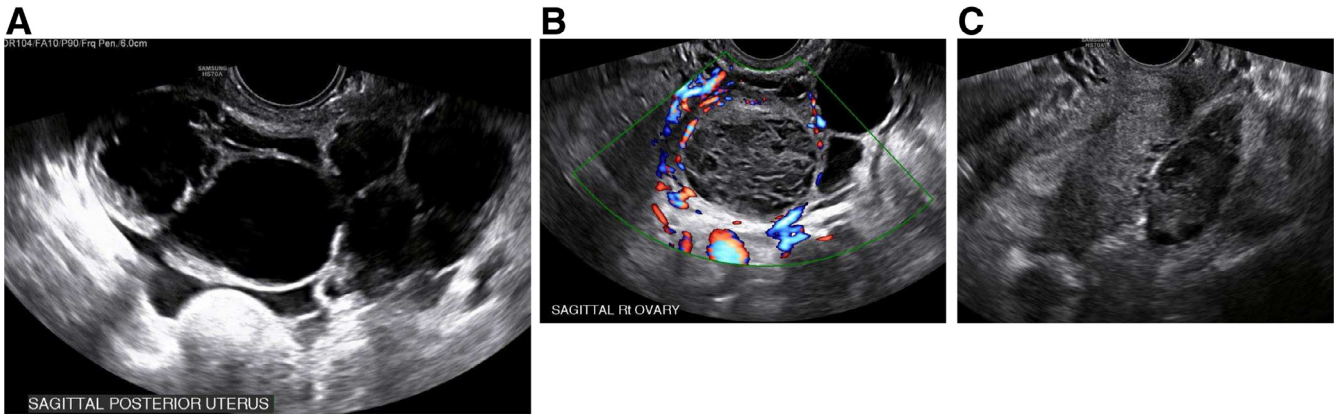

Figure 10 Paraovarian multilocular cyst.

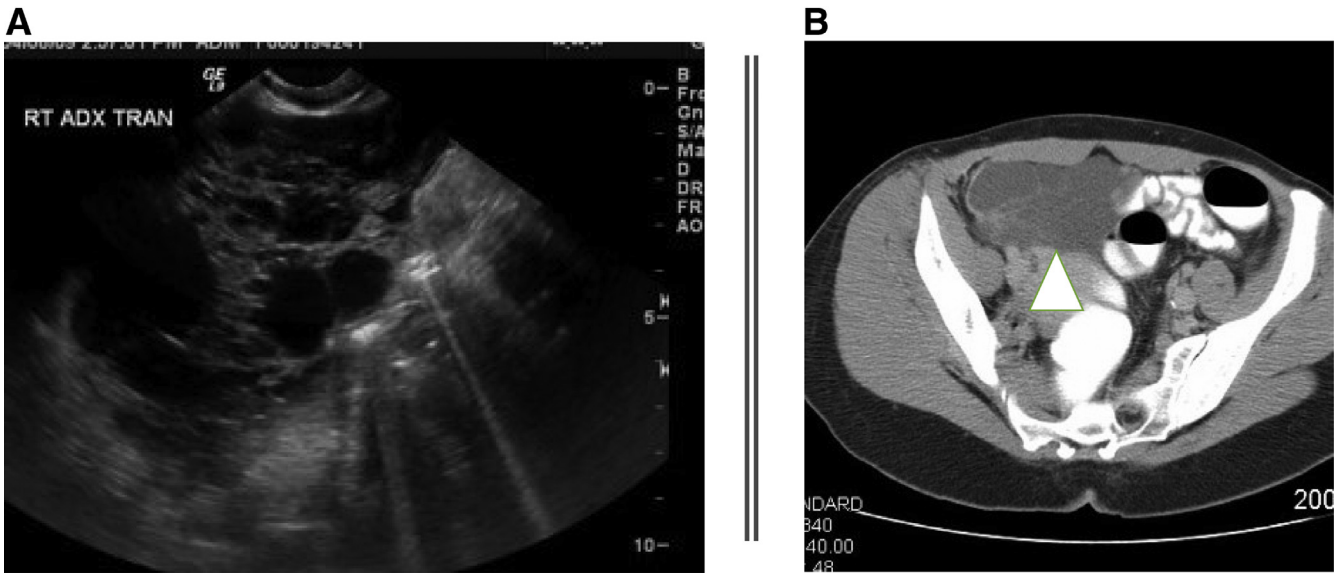

Figure 11 Mucocele of the Appendix.

In one series 15.6% of paraovarian cysts were proven to be cystadenomatoid tumors.[26] A majority of the paraovarian cysts are typically simple unilocular cysts with no vascular flow. Benign and borderline malignancy is rare in paraovarian cysts.[28] Presence of thick wall and solid components is suggestive of a cystadenoma or cystadenofibromas. Malignancy in a paraovarian cyst is extremely rare.[23,28] Borderline tumors in paraovarian cysts are rare and characteristically show papillary excrescences projecting into the cysts. As in ovarian tumors, presence of larger papillary projections and or solid components increases the likelihood of malignancy. Paraovarian cyst can undergo torsion in which a symptomatic patient can appear as a paraovarian cyst with thick wall and hemorrhagic content. Distinction of paraovarian cysts from ovarian cysts can occasionally be challenging.[27] Differential diagnosis would include a hydrosalpinx, an ovarian cyst and a peritoneal inclusion cyst.

Mucocele of the Appendix

Mucocele of the appendix is characterized by a cystic dilation of the appendix caused by luminal obstruction. The underlying causes of a mucocele can be a cystadenoma (63%), mucosal hyperplasia (25%), or cystadenocarcinoma (11%) of the appendix. The multiloculated cystic mass of a mucocele extends inferiorly from the base of the appendix into the right adnexa and may simulate a right ovarian multilocular cystic tumor (Fig. 11).[28-31] About 25% of mucoceles of the appendix are asymptomatic, 64% present with a right lower quadrant pain.[28] Mean age of presentation for a benign cystadenoma of the appendix is 54 years and for the malignant counterpart is 64 years, a multiloculated cystic mass is seen which on MRI may demonstrate enhancement of the septa.[29] A right adnexal cystic mass may also be an incidental finding on a pelvic ultrasound scan performed for another indication.[30] Serum CA-125 is often normal. Aspiration or percutaneous intervention should be avoided to eliminate the risk of spread of the tumor contents leading to pseudomyxoma peritonei. Preoperative diagnosis is important, and CT or MRI will correctly identify the appendiceal origin of the cystic mass. On MRI, mucoceles appear as a well-defined cystic mass with low to intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images which is attributed to its high

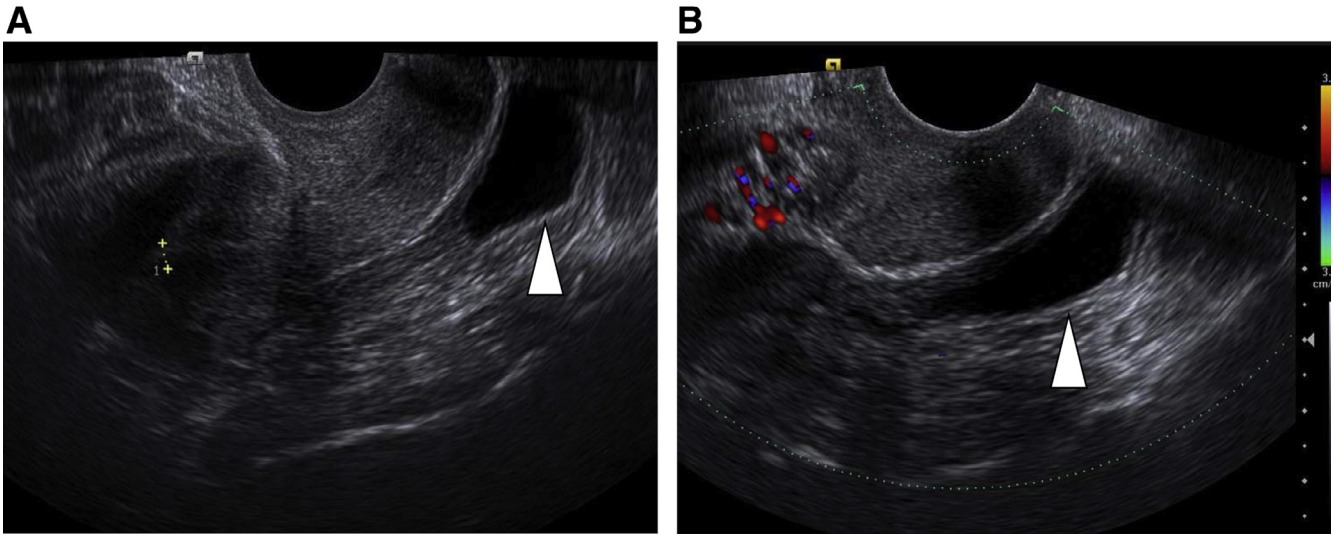

Figure 12 Rectal duplication cyst.

mucin content.[30] CT may show characteristic curvilinear mural calcification which is however seen in about 50% of cases only. Ultrasound shows a unilocular or multilocular cystic mass in the right adnexa with anechoic contents or low-level echoes. Differential diagnosis for the cystic mass would include an ovarian neoplasm, lymphocele, a paraovarian cyst, or an enteric duplication cyst.[30] An "onion sign" has been described as being characteristic consisting of echogenic layers within a cystic mass resembling the circles of an onion.[28,31]

Rectal Duplication Cyst

Tailgut cyst or a rectal duplication cyst is uncommon congenital lesion that arises from remnants of the embryonic postanal gut (Fig. 12). It is usually retro rectal and appears as a presacral cystic mass, when large it can extend laterally and mimic an adnexal cystic mass. On imaging, it may appear multilocular and be confused with a cystic ovarian neoplasm particularly in older women when an atrophic ovary is not seen. Surgical excision is the preferred treatment once preoperative imaging has excluded a malignant ovarian neoplasm.[21,32]

Spinal Meningeal Cyst

Spinal meningeal cysts are caused by a diverticulum of the spinal meningeal sac, nerve root sheath, or arachnoid. These cystic lesions may be unilocular or multilocular. On a transvaginal scan in a postmenopausal patient, these lesions may be mistaken for a multilocular cystic ovarian tumor. Continuity with the sacrum is the key for an accurate diagnosis, this may not always be possible particularly on ultrasound (Fig. 13). MR or CT imaging clearly demonstrates the connection of the cystic mass with the thecal sac or nerve roots.[9] About 90% of patients with Marfans syndrome will have dural ectasia, and when severe an anterior sacral meningocele may develop, and may be confused for a cystic ovarian tumor.[21] On CT and MRI scalloping of the adjacent bone without cortical disruption and widening of the sacral canal and foramina without solid enhancing components is diagnostic of spinal meningeal cysts and serves to exclude an ovarian tumor.[20]

Lymphocele

Pelvic lymphoceles appears as lateral pelvic cystic masses in patients with previous trauma to lymphatic structures usually from a prior surgery, particularly after a lymphadenectomy. Symptoms may result from infection or a mass effect. Because of the underlying history, finding of a thin walled cystic mass with low T1 signal and high T2 signal and without solid enhancing components is characteristic of a lymphocele. Presence of an adjacent susceptibility artifact resulting from surgical clips aids in the diagnosis. Occasionally internal septations may be seen mimicking the appearance of a cystic ovarian neoplasm.[9] When enhancing soft tissue structures are seen in association with a lymphocele, tumor recurrence is the likely cause. This may simulate an ovarian malignancy, however the underlying history and a lateral relationship to side wall pelvic vasculature is a clue to the correct etiology.[9]

Solid Extraovarian Mass

Parasitic Fibroid and Broad Ligament Fibroid

The most common cause of a solid adnexal mass is a pedunculated fibroid. The diagnosis is made by identifying bridging vessels. Presence of a Mullerian fusion anomaly can also cause an extraovarian mass mimicking an ovarian mass. MRI is helpful in doubtful cases by demonstrating normal ovaries separate from these masses.[33,34] Parasitic and broad ligament fibroids are more challenging due to lack of communication

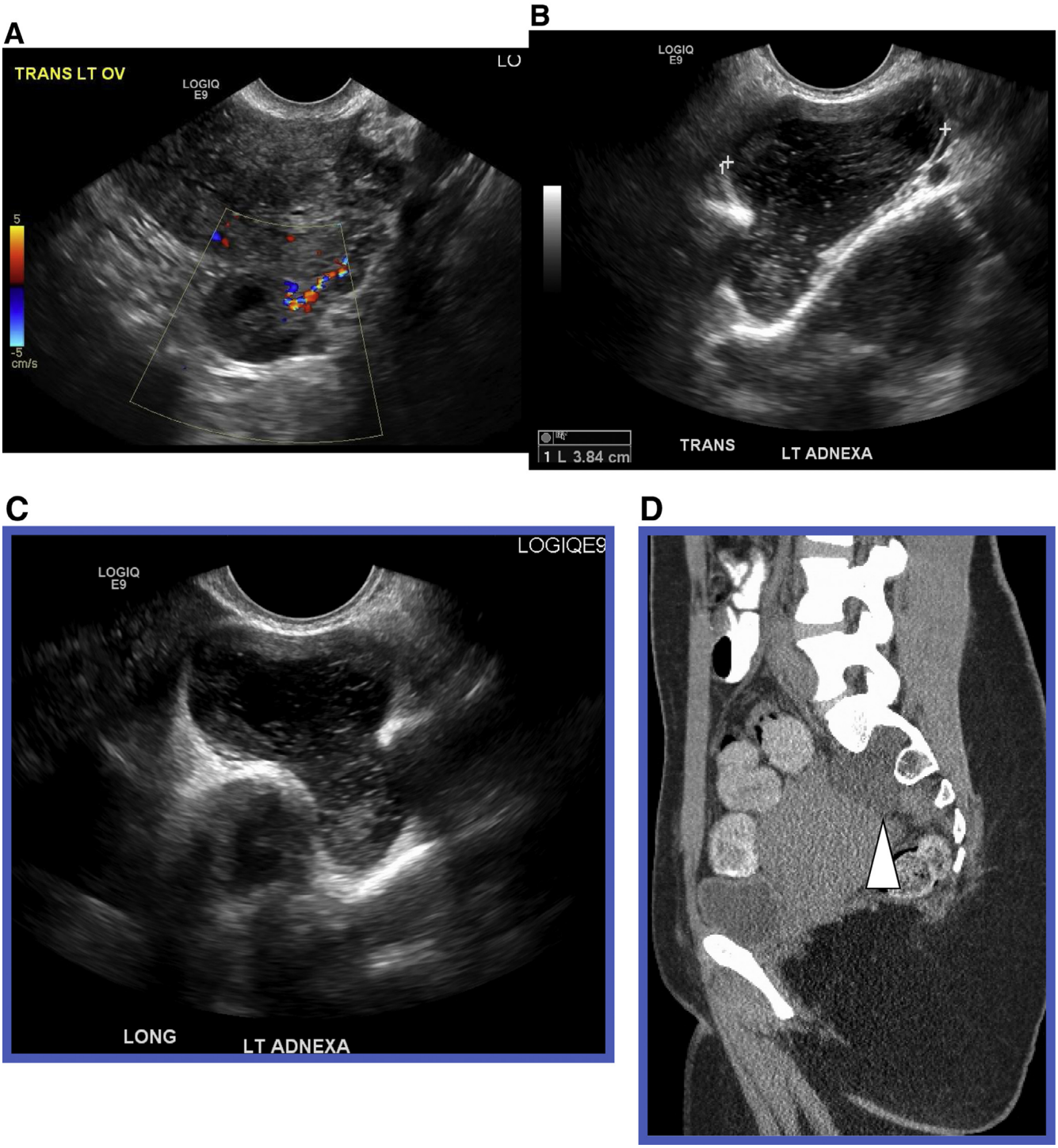

Figure 13 Spinal meningeal cyst.

with the uterus (Fig. 14).[33-35] MRI demonstrates splaying of the myometrium around the mass, typical signal characteristics of low to intermediate signal on T1-weighted sequence and low T2-weighted signal intensity and postcontrast enhancement. Cystic degeneration, fatty change, and hemorrhage within fibroids will change the signal characteristics of these fibroids. Vessels extending from the uterus to the lateral exophytic fibroids appear as tortuous signal voids and are referred to as the bridging vessel sign.[20]

Extraovarian fibrothecomas very rarely may present outside the ovary with a clinical and imaging appearance similar to metastatic epithelial ovarian cancer (Fig. 15). Patients present with weight loss, abdominal pelvic mass, ascites, and an elevated CA-125. At imaging a large solid adnexal mass with cystic changes and associated with ascites is seen.[36-38] A presumptive diagnosis of a malignant epithelial ovarian tumor may lead to erroneous administration of neoadjuvant chemotherapy prior to debulking surgery, it is therefore

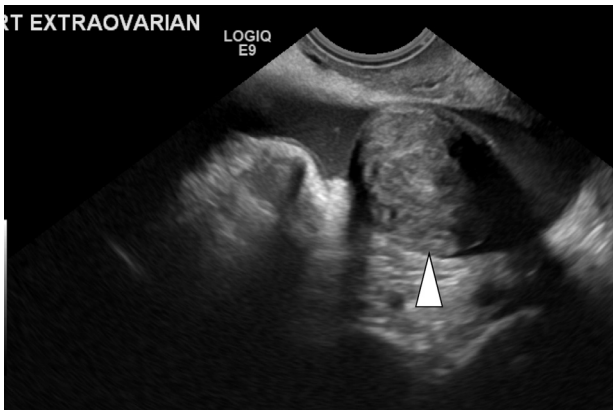

Figure 14 Broad ligament fibroid.

imperative to get a histological diagnosis prior to chemotherapy. Needle biopsy will correctly diagnose the spindle cell tumor and avoid mismanagement as a metastatic ovarian malignancy. These tumors are presumed to arise from ectopic ovarian tissue.[36] MRI imaging demonstrates extrauterine predominantly solid mass, ipsilateral and contralateral ovaries. The tumor appears hypo- or isointense on T1-weighted sequence and hypointense on T2-weighted sequence with enhancement less than a fibroid, typically are larger than 6 cm tumors have a capsule.[36,38] These are rare tumors and most of the reported cases of extraovarian stromal tumors arise in the broad ligament.[38]

Chronic pelvic hematoma related to past pelvic surgery, trauma, or parturition may present as an incidental solid adnexal mass on a pelvic ultrasound and mimic a solid ovarian neoplasm (Fig. 16). Cystic components may be associated. These are typically avascular. A definitive diagnosis is made on MRI with subacute hematomas exhibiting high intensity on T1-weighted images and low to variable signal intensity on the T2-weighted images. Chronic hematomas have low T1 and T2 signals due to hemosiderin deposition. Concentric rings of alternate signals may be seen when there is a combination of acute and subacute hematoma. There is no enhancing solid component in a hematoma.[19] (Fig. 16)

Gastrointestinal stromal tumors (GIST) are the most common mesenchymal tumors of the gastrointestinal tract.[39-45] These are uncommon tumors accounting for 1%-3% of gastrointestinal malignancies. Majority of these tumors occur in

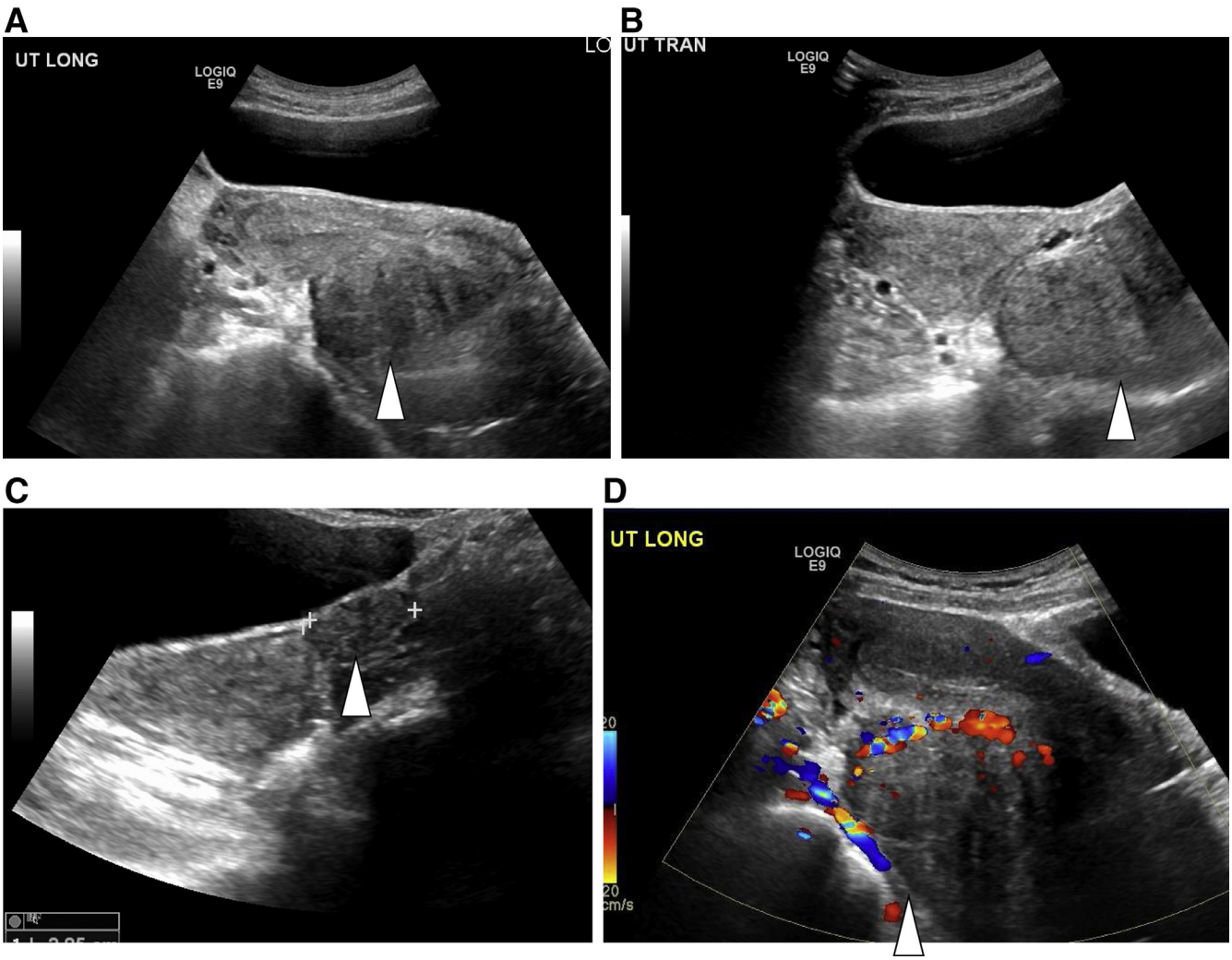

Figure 15 Extraovarian fibrothecoma.

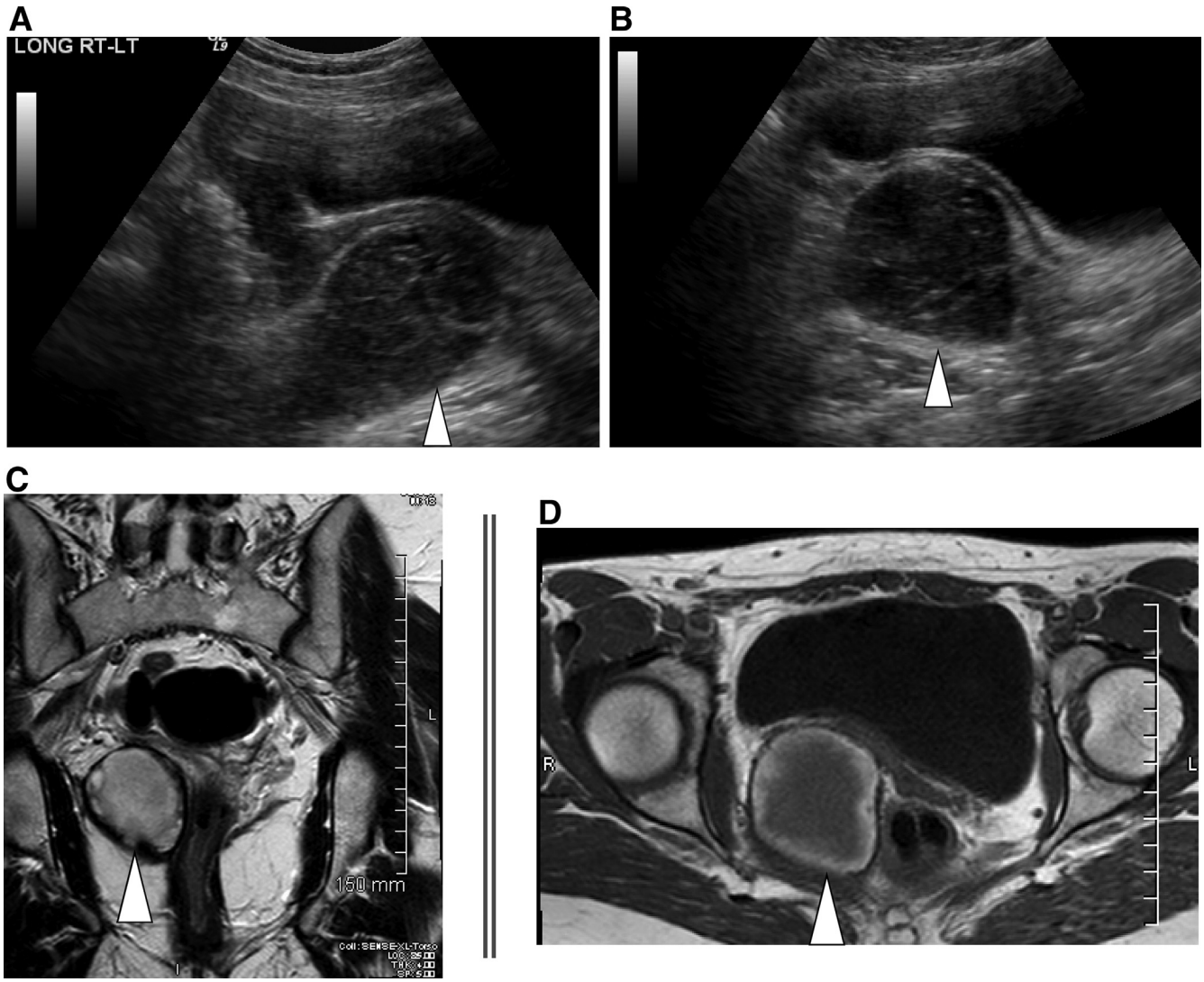

Figure 16 Chronic pelvic hematoma.

the stomach. GISTs appearing as a solid pelvic mass are those that arise from the small intestine or distal colon or rectum (Fig. 17). About a third of the GIST arise in the small intestine.[40] Lymph node involvement is uncommon, and bowel obstruction is seldom the presenting feature since tumor is exophytic. Recurrence rate is high (40%-90%) likely due to tumor spillage during excision, so meticulous surgical technique is critical and needle biopsy is best avoided.[39,40] These tumors typically affect older individuals. On imaging these tumors may be predominantly solid or mixed solid and cystic, and when seen laterally in the pelvis without identifiable normal ovary can be mistaken for ovarian malignancy particularly in post-menopausal women in whom atrophic ovaries are difficult to identify.[41] When predominantly solid, these tumors may be mistaken for a leiomyomas or solid ovarian neoplasms on ultrasound.[41-44] Multiplanar CT scan imaging is helpful in correctly identifying the origin of the tumor from bowel by showing a pedicle.[42,43] Central cystic changes may closely mimic a cystic ovarian tumor.[33] Accurate preoperative diagnosis allows for optimal surgical planning. These masses may show variable vascularity; gastric GIST appears to be more vascular than the enteric GIST. Central hemorrhage may appear hyperechoic on ultrasound.[39] CT is also useful in identifying hepatic and omental metastasis.[32] When predominantly solid they can be preoperatively mistaken for an ovarian fibroma, in these instances at surgery an atrophic ovary is often found attached to the tumor.[45]

Pelvic metastasis appears as predominantly solid extrauterine masses and as masses in the cul de sac. When a normal ovary is not seen separately these tumors may mimic an ovarian malignancy. Lymphoma and metastasis from breast, colon, and lung are the most common source. On MRI metastasis exhibit low to intermediate signal intensity on T1-weighted sequences and slightly hyperintense on the T2-weighted imaging sequence relative to skeletal muscle. Signal characteristic will vary if there is hemorrhage within the tumor leading to cystic changes. Post-contrast images demonstrate enhancement of the solid portions of the tumor. Pelvic lymphadenopathy when seen in association with a solid adnexal extraovarian mass is helpful in making a presumptive diagnosis of metastasis.[20]

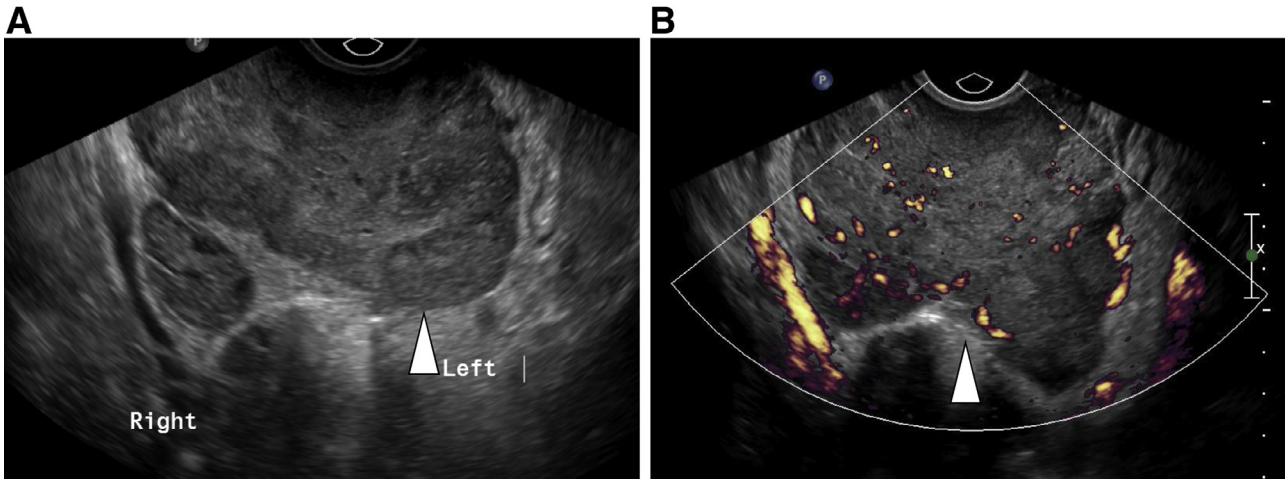

Figure 17 Gastrointestinal stromal tumor.

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