

## CYSTIC LESIONS OF THE FEMALE REPRODUCTIVE SYSTEM: A REVIEW\*

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**In order to avoid unnecessary therapy or treatment delay, it is important for the radiologist to be aware of the wide range of differential diagnoses for cystic lesions of the female reproductive system. This paper gives an overview of radiological findings in the variety of physiologic and pathologic cysts which may be encountered in this field.**

**Key-words:** Pelvic organs, cysts.

Lesions of the female reproductive system comprise a large number of physiologic and pathologic cysts. In order to avoid unnecessary therapy or treatment delay, it is important for the radiologist to be aware of the wide range of differential diagnoses in this particular field. Since clinical symptoms of pelvic cystic lesions are often non-specific, a correct state-of-the-art radiological work-up is all the more important.

Transabdominal and more specific transvaginal ultrasound (TVUS) are definitely the first line exams in the work-up of lesions of the female reproductive system, because of three major advantages: convenience, low-invasiveness and cost effectiveness. Magnetic resonance imaging (MRI) on the other hand is known to be a valuable adjunctive modality for the cystic lesion work-up (1). High-resolution multi-planar MRI imaging using a dedicated phased array coil allows detailed anatomic pelvic evaluation. Moreover, MRI is considered an ideal additional modality in this area because of its superb soft-tissue contrast, its lack of radiation exposure and high sensitivity for fluid detection. In our opinion, CT should be reserved for oncological staging and emergency settings where the quick availability of MRI is lacking.

The use of contrast should carefully be considered for each patient individually, since not every physiological cyst requires a contrast enhanced study. Contrast enhanced dynamic MRI studies however offer great help in detecting and characterizing solid vascularized components of pelvic neoplasms and peritoneal spread of malignant disease. Therefore, the use of contrast offers

great advantage in diagnosing and staging tumorous lesions in this complex area.

In this article, we discuss the radiological findings for pelvic cystic lesions in the female reproductive context and emphasize some key points each radiologist should be familiar with. The cystic findings discussed include vaginal cysts type embryonic cysts, inclusion cysts and bartholin gland cysts, uterine endometrial, as well as myometrial cysts, cervical benign and malignant cystic lesions, the non-significant paraovarian cysts, physiological and complex ovarian cysts and the wide variety of benign, borderline and malignant ovarian tumors. Finally, we end by emphasizing some acute problems, that may be of interest for the radiologist in an on-call setting.

### Vaginal cysts

Vaginal cysts may be embryologic or acquired. Acquired vaginal inclusion cysts or epidermal inclusion cysts can form at a given site following former trauma or surgery. Müllerian and Gartner cysts, both embryonic cysts, are typically located in the anterolateral vagina. Usually, they present as asymptomatic simple cysts with sizes ranging from 1 to 7 cm (2). Occasionally, they cause a variety of symptoms such as pain, dyspareunia, voiding complaints, sense of vaginal pressure, or a palpable mass (3). While the commonest type, the Müllerian cyst, is a remnant of the paramesonephric duct, the Gartner cyst originates from the mesonephric duct. Distinction between the two embryologic cysts can only be made by means of histological examina-

tion, but is not clinically significant as both cysts are managed in a similar fashion: large symptomatic cysts are usually excised (4). It is however important for the radiologist to be aware of the association between Gartner cyst and metanephric abnormalities such as unilateral renal agenesis, renal hypoplasia and ectopic ureteral insertion (5).

High resolution multiplanar T2-weighted MRI imaging is the modality of choice for evaluating such vaginal cysts, as it exhibits the cystic nature of the lesions and differentiates them from urethral diverticula. Signal intensity on T1-weighted imaging without contrast varies from low to high, depending on the mucine or hemorrhagic content. No contrast enhancement is to be expected.

The most frequently encountered cyst on cross sectional imaging, the bartholin cyst, is typically located more posteriorly and caudally, in the posterolateral introitus and medial to the labia minora. Bartholin gland cysts are typically retention cysts from chronic inflammation, which leads to ductal obstruction from pus or thick mucus within the bartholin glands. In a bartholin cyst varying contents of mucin and hemorrhage may lead to spontaneous high signal intensity on T<sub>1</sub> (Fig. 1). Whenever superimposed infection occurs, it presents as air-fluid levels within the cyst and an irregular rim enhancement on CT or MRI.

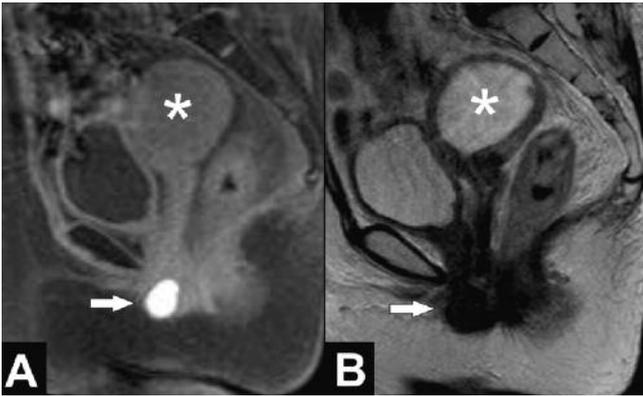
### Uterine cysts

Occasionally in the elderly, ultrasound (US) or MRI reveals a cystic gland dilatation combined with endometrial atrophy: cystic endometrial atrophy (Fig. 2). The endometrium presents in such case as a very thin atrophic layer of 4 to 5 mm. Cystic endometrial hyperplasia, on the other hand, is characterized by similar small endometrial cysts in an evenly thickened endometrium of over 5 to 6 mm. Both entities are not premalignant, provided the endometrium is evenly echogenic.

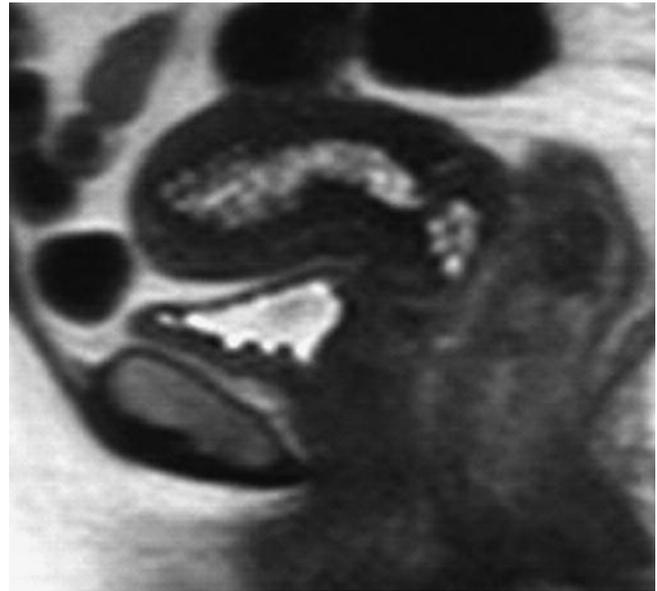
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*Fig. 1.* — Follow-up MRI in the context of cervix carcinoma in a 80-year old female: unenhanced sagittal T1-weighted (A) and T2-weighted (B) images made in the context of a follow-up for cervix carcinoma in complete remission shows fluid accumulation in the uterus (\*) caused by cervical stenosis post radiotherapy. The hyperintense cystic lesion at the introitus (arrow) which is hyperintense on T1 and hypointense on T2 is an uncomplicated Bartholin cyst and an incidental finding. Hypointensity on T2 is caused by a hemorrhagic content of this cyst.



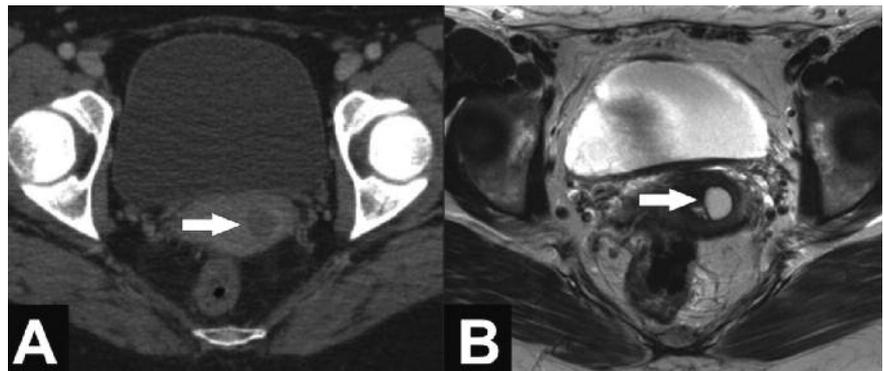
*Fig. 2.* — Sagittal T2-weighted image in a 81-year old woman in the context of a staging for rectal carcinoma: incidentally, the small endometrial cysts of cystic endometrial atrophy are present throughout the uterus.

Junctional zone myometrial cysts can be encountered in the uterus and are highly specific for adenomyosis. These small and easy to depict myometrial cysts may be the first to draw attention on either US or MRI to the associated thickened junctional layer of  $\geq 12$  mm in adenomyosis. Such high T2-weighted signal intensity cysts within the junctional zone may have high signal intensity on native T1-weighted imaging as well and are in fact trapped endometrial glands.

#### Cervical cysts

On cross sectional imaging of the cervix, common retention cysts are a typical incidental finding and range from a few mm to 4 cm. They are called nabothian cysts and typically present as a sharply delineated cervical cyst, without contrast enhancement (Fig. 3). Signal intensity is high on T2-weighted imaging, while high signal intensity on unenhanced T1-weighted imaging can occasionally be produced by the presence of protein content or hemorrhage.

A tunnel cluster is a special type or cluster of nabothian cysts that we may encounter as a complex multicystic mass filling the endocervical channel (6). Moreover, there exists an overlap in imaging characteristics between such a tunnel cluster, a severe endocervical hyperplasia and a cervical polyp. Unfortunately, since imaging findings overlap, exact differentiation of the latter three benign



*Fig. 3.* — Contrast enhanced CT in venous phase (A) and corresponding T2-weighted high resolution MR image at 3T shows a typical nabothian cyst in the cervix (arrow) with clear cystic content and sharp edges and without any contrast enhancement.

entities with adenoma malignum, a rare minimally invasive adenocarcinoma, is occasionally difficult (7). Besides a watery discharge, which is the most common initial symptom of adenoma malignum, solid components in the deep cervical stroma with enhancement in a complex multicystic mass filling the endocervical channel are suspicious of adenoma malignum (7, 8).

#### Paraovarian cysts

Paraovarian cysts like paraöphoron, epoöphoron and hydatids of Morgagni or appendices vesiculosae, the latter being attached

to the fringes of the tube, are merely an incidental MRI finding and present as thin walled unilocular simple cysts filled with clear serous fluid. They are of low significance to the radiologist, since they are harmless.

#### Physiological and functional ovarian cysts

The Graafian or dominant follicle is found at mid cycle and its size ranges up to 25 mm (1). After ovulation, the corpus luteum remains and is typically a cystic structure of less than 15 mm. While follicles and the dominant follicle are anechoic and thin walled, corpus luteum is typical-



*Fig. 4.* — Contrast enhanced CT in the venous phase in a young female performed to exclude acute appendicitis in an emergency setting, reveals a thick walled somewhat collapsed cystic structure in the right ovary (arrow). In this corpus luteum, contrast enhancement in the thick wall is evident. An intra-uterine device is also present.

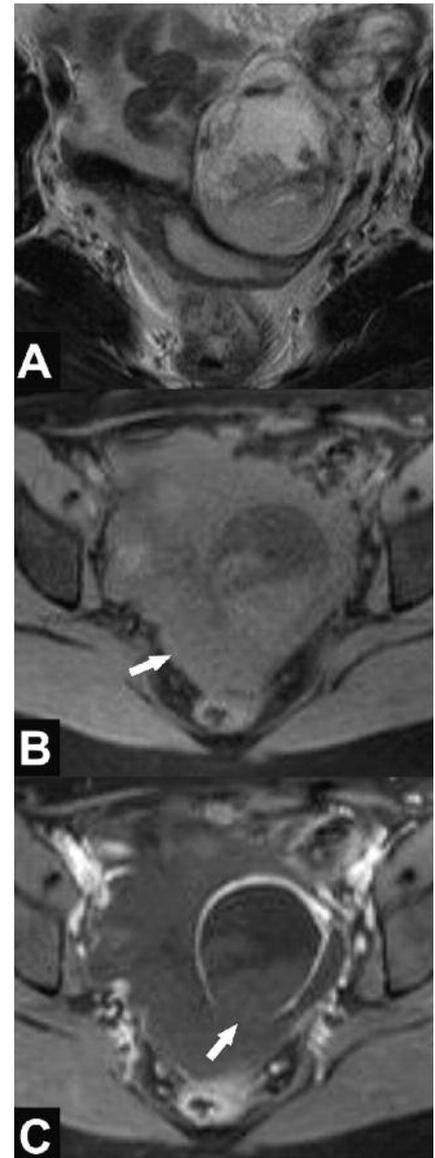
ly presenting with a thick and occasionally convoluted and enhancing wall (Fig. 4). Some degree of blood content, producing scattered internal echoes, is also frequent. If conception does not occur, the corpus luteum involutes into the corpus albicans, which we do not see on imaging. It is important for clarity not to refer to these physiological cystic findings as cysts, but to use the term follicle.

A true follicle cyst on the other hand develops when the follicle fails to regress or ovulate, and is typically a 3 to 8 cm unilocular thin walled cyst, that may contain a small amount of blood (9). When the corpus luteum fails to regress after ovulation, which can be seen during the end luteal phase or during pregnancy, it turns into a 2.5 to 6 cm thick walled cyst (10), which is prone to bleed (Fig. 5) and may even reach up to 15 cm in pregnancy. The thick cyst wall may exhibit slightly increased intensity on unenhanced T1-weighted images and relatively low signal intensity on T2-weighted images. Avid enhancement of the cyst wall, reflecting increased vascularity of the thick luteinized cell layer (1), can occur. We should take into account that not only the corpus luteum and corpus luteum cyst but all these

physiological cysts may present on cross sectional imaging with a contrast enhancing wall.

Information about the patient's menstrual cycle at the time of imaging is mandatory in order to be able to differentiate follicle, dominant follicle, corpus luteum, follicular cyst and corpus luteum cyst, since diagnosis of such entities relies on the date in the menstrual phase. Also, since a follicular cyst of more than 5 cm may be indistinguishable from a neoplastic cyst, such as serous cystadenoma, monitoring by follow up TVUS (1) is advocated. Indeed, unlike neoplastic cysts, physiological cysts will regress usually within two menstrual cycles.

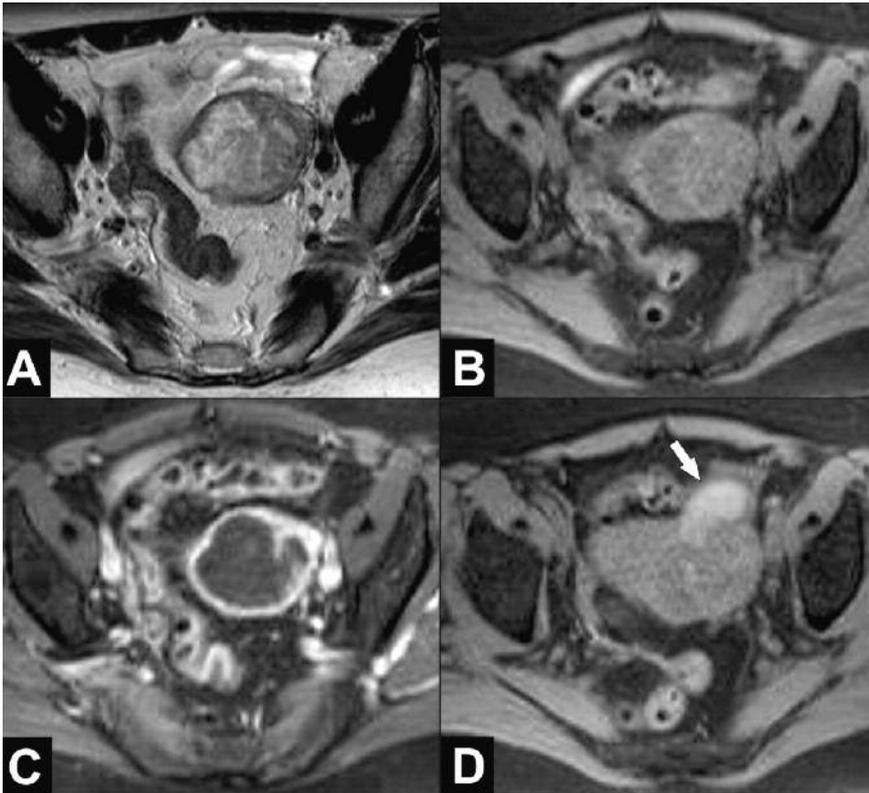
Theca lutein cysts or hyperstimulation cysts are associated with abnormal high levels of bHCG (human chorionic gonadotropine) as in multiple gestations, trophoblastic disease and most commonly due to pharmacologic hyperstimulation. The TVUS signs for theca luteine cysts are enlarged ovaries of > 5 cm in association with multiple follicular cysts, corpora lutea and edematous stroma. The key imaging finding to make the differentiation with multilocular bilateral cystic ovarian tumor is the uniform size of each locule in theca lutein cyst (11).



*Fig. 5.* — T2-weighted (A), unenhanced (B) and enhanced (C) T1-weighted images in a 19-year old female with a history of Von Willebrand factor deficit and presenting with acute abdominal pain caused by a ruptured hemorrhagic corpus luteum cyst: a somewhat thicker walled large ovarian cyst is seen on the left as well as high signal intensity free fluid on T1 (arrow, B). The bottom content of the cyst is hypointense on T2 (A) and hyperintense on T1 (B), which is typical for an organized hematoma. A clear enhancement (C) can be seen in the cyst wall, which presents with an interruption (arrow, C). The absence of papillary projections and enhancement of the internal structure of the cyst exclude malignancy.

#### **Complex ovarian cysts: endometrioma**

Endometriosis is defined as the presence of extrauterine endo-



**Fig. 6.** — T2-weighted (A), unenhanced T1-weighted (B, D), and enhanced T1-weighted image in the venous phase (C) in a 61-year old woman with a persistent ovarian cyst on the left. The internal structure of the cyst shows heterogeneous hypointensity on T2 (A) and hyperintensity on T1 (B), consistent with internal hematoma. High signal intensity on native T1 is consistent with hematosalpinx (arrow, D). Contrast enhanced T1 (C) seems to demonstrate papillary projections on the anterior and left cyst wall, which lead to the preoperative diagnosis of malignant cystic tumor type mucinous cystadenocarcinoma. However, pathology of the adnexectomy specimen revealed an endometrioma, without malignancy.

metrial tissue. The most common location of pelvic endometriosis is the ovarian endometrioma, a complex cyst containing blood products. Endometriomas are usually multiple and do not disappear in 2 month TVUS follow-up, in contrast to a unilateral hemorrhagic follicular or corpus luteum cyst. Characteristic sonographic features of endometriomas are diffuse low-level internal echoes, multilocularity and hyperechoic foci in the wall (12). On US, no color Doppler signals are to be expected in this complex cyst.

The various stages of the blood products in the endometrioma cause the typical MRI findings: high signal intensity on unenhanced T1-weighted imaging and low signal intensity on T2. This phenomenon is called shading (1). It is important to perform fat saturation techniques on MRI in order to distinguish this high signal intensity on unenhanced T1

from fat presence. Occasionally, it can be difficult to differentiate a complex endometrioma from a malignant ovarian tumor (Fig. 6).

Because of the risk in endometrioma of developing a secondary neoplasm, it is mandatory to look for solid enhancing components on the endometrioma cyst wall, which are suspicious of malignant transformation. 1% of endometriomas undergo malignant transformation into endometrioid adenocarcinoma and clear-cell carcinoma (1). Decidual changes of an endometrioma cyst wall during pregnancy may resemble solid malignant components. These decidual changes can however be distinguished, since they present with similar signal intensity on MRI as normal endometrium on all MRI sequences: on unenhanced T1, a high signal intensity endometrioma cyst will present with low signal intensity from pregnancy decidual

changes, while on T2 the cyst compound will be low signal intensity with high signal intensity mural nodules (1).

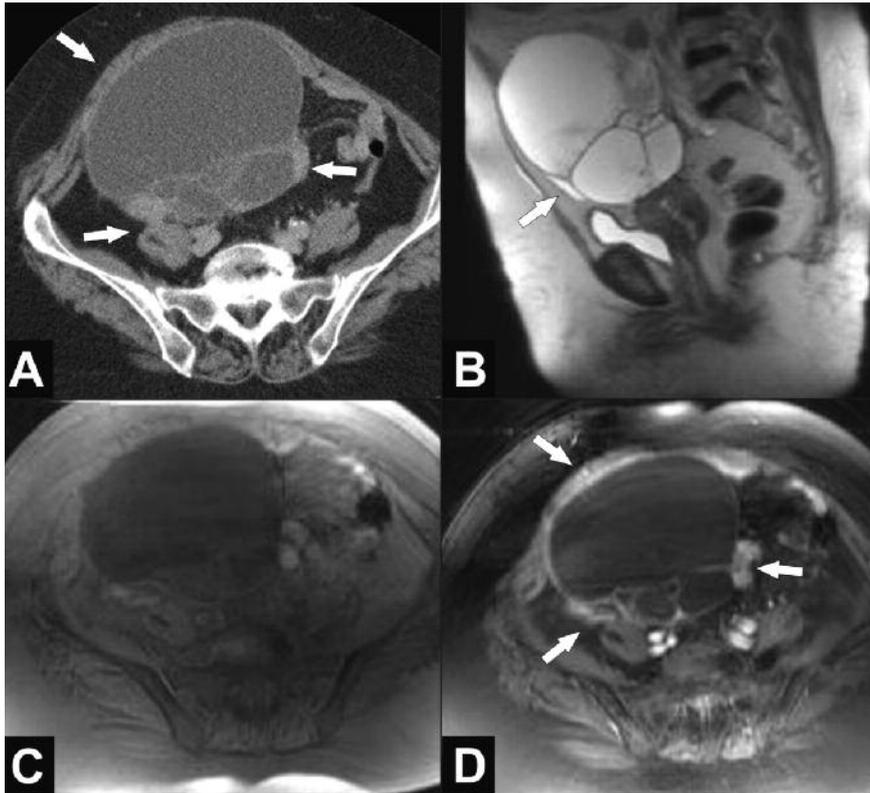
### Cystic ovarian tumors

Cystic ovarian tumors are classified on the basis of tumor origin as epithelial, germ cell and sex cord stromal tumors.

The subtypes of epithelial tumors include serous, mucinous, endometrioid and clear cell tumors. They represent 60% of all ovarian and 85% of malignant ovarian neoplasms (13) and their prevalence increases with age, peaking in the sixth and seventh decade of life (14). Of all malignant ovarian tumors, 50% are serous and only 10% are mucinous epithelial tumors (15). In general, serous lesions tend to be smaller, unilocular, thin walled and malignant and may mimic functional cysts, whereas mucinous tumors are mostly benign, larger and typically present with a multilocular, stained glass or honeycomb-like locular appearance (15). CT attenuation or MRI signal intensity of the different locules is variable (Fig. 7), due to the difference in degree of mucinous or proteinous cyst content (15). Commonly, serous epithelial tumors are more frequently bilateral and may exhibit psammomatous calcifications. Mucinous epithelial tumors, on the other hand, are mostly unilateral and rarely present with some linear calcifications (15). Mucinous adenocarcinoma can rupture and is associated with pseudomyxoma peritonei.

In spite of the considerable overlap in morphologic characteristics and corresponding imaging features, that in many cases prevents definitive preoperative characterization as benign or malignant, besides the obvious presence of either ascitis, peritoneal implants and adenopathies, features suggestive of malignancy in a cyst are: solid elements and either endocystic or exocystic papillary projections, wall and/or septation thickness of more than 3 mm and color flow in the solid components (15).

Although rare, endometrioid carcinoma is the most common tumor arising from endometriosis, followed by clear cell tumor. It is associated with endometrial hyperplasia. Unfortunately, imaging findings are non-specific and are those of a large complex cystic mass with solid components (15).



**Fig. 7** — 85-year-old female with an anatomopathologically proven cystadenocarcinoma. Venous phase CT (A) shows a multiloculated septated cystic mass with enhancing solid vegetations on the cyst wall (arrow, A). Sagittal T2-weighted image (B) and axial T1-weighted image without (C) and with contrast (D) reveal the same findings. In B (arrow), some ascites is present. Some locule contents seem of higher signal intensity (C), which is suggestive of a mucinous content. T1-weighted enhanced image (D) at the same level as CT (A) reveals similar solid parts in the cysts wall (arrows). The anterior cyst wall contrast enhancing exocystic papillary projections are more easily depicted on MRI (D) compared to CT (A).

The mature teratoma or dermoid cyst is the most common ovarian mass in children. It is a predominantly cystic germ cell tumor, containing fat or dense calcifications with a bilateral presentation in 8-25% of the cases. Most mature cystic teratomas can be diagnosed at US, although a variety of appearances, characterized by echogenic sebaceous material and calcification, is possible. Sebum and hair compounds present as echogenic components on US. MRI and CT are able to demonstrate the fat component of the tumor well, which is diagnostic (Fig. 8). Since fat presents as high signal intensity on both T1 and T2-weighted imaging, fat saturation technique allows easy confirmation of this high signal intensity compounds as fat (16).

Besides the most common malignant sex cord stromal tumor (15), a granulosa cell tumor is also the most common estrogen producing ovarian tumor. Imaging findings vary

widely from solid to multilocular and the tumor may present as a multicystic lesion with enhancing solid portions (15).

It is most important not to misdiagnose physiologic changes of the ovary as pathologic cysts. On the other hand, we should be aware that ovarian masses in young women could indeed represent malignancy. It is therefore recommended in premenopausal women, that a unilocular thin walled cyst of 2.5 to 6 cm should have follow-up TVUS in two months. Follow-up should take place in the immediate postmenstrual period, when follicular cysts are not to be expected. In unilocular cysts exceeding 6 cm surgery is recommended.

In postmenopausal women, a serial follow-up is to be considered in the case of a unilocular non-septated thin walled cyst of less than 3 cm, while a larger cyst and/or any signs suggestive of malignancy

should immediately be followed by CA125 determination and surgical exploration. Of course, in the elderly, the individual patient constitution should be taken into account.

### Acute problems

Ectopic pregnancy, hemorrhage within a cyst with or without cyst rupture and infection are acute problems that can be encountered in emergency radiology.

Ectopic pregnancy remains the leading cause of death during the first trimester of pregnancy. The initial evaluation of patients suspected to have an ectopic pregnancy entails a bHCG determination and TVUS. The absence of intrauterine pregnancy beyond 6 weeks menstrual age and elevated bHCG levels are highly suspicious of extrauterine pregnancy.

An ectopic pregnancy is 95% tubal (17) and associated with hematosalpinx and/or hemoperitoneum. An adnexal mass that is separate from the ovary is the most common finding of a tubal pregnancy and is seen in up to 89-100% of patients (18). The second most common sign is the tubal ring sign, which describes a hyperechoic ring surrounding the extrauterine gestational sac. A related finding is the ring of fire sign, which is recognized by peripheral hypervascularity of the hyperechoic ring (19) on Color Doppler US. An adnexal mass is more specific for an ectopic pregnancy when it contains a yolk sac or a living embryo or when it moves independently from the ovary (20). Of course, the presence of an embryonic heartbeat within an adnexal mass is pathognomonic.

Hemorrhage and cyst rupture occasionally occur in a corpus luteum cyst without predisposition. Ovarian cyst rupture causes an acute pain with sudden onset. Evidently, bleeding disorders are predisposing factors for such an event to occur (Fig. 5). As with ovarian torsion and extrauterine pregnancy, ultrasound is the first-line imaging modality for suspected ovarian cyst hemorrhage or rupture. Bleeding causes a complex pattern of echoes within the cyst. The typical US appearance is that of an enlarged ovary, containing often bizarre mixed echoes caused by blood clot and arranged in a reticular pattern, sometimes likened to a spider's web. On pressure of the trans vaginal probe, the blood clot within the cyst may seem to wobble in a jelly-like fashion (21). Cyst

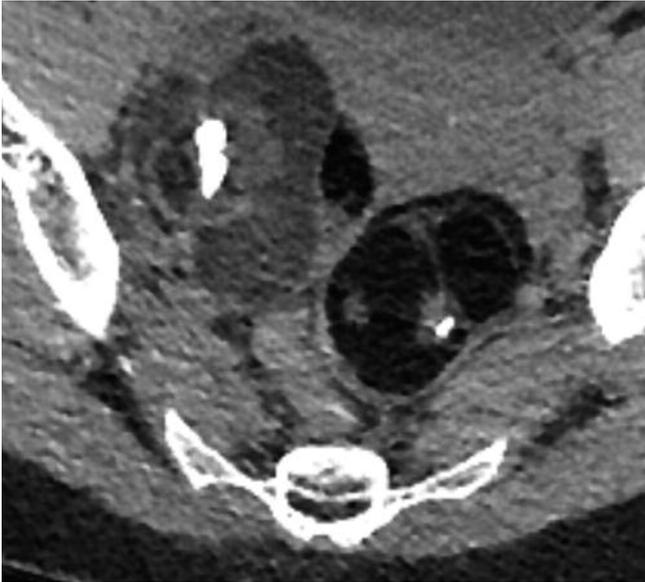


Fig. 8. — Unenhanced uro CT performed in a 30-year old woman in an emergency setting demonstrates the incidental finding of a bilateral mature teratoma. The hypodense fat components are diagnostic and present bilaterally, besides calcification and sebaceous material.

rupture causes the presence of high density free pelvic fluid on CT, with higher signal intensity on unenhanced T1-weighted imaging (Fig. 5).

A tubo-ovarian abscess is a multilocular complex mass with debris, septation and irregular thick rim enhancement that may contain fluid-fluid levels or gas. When dealing with such an abscess, it is mandatory to explore the contra lateral adnex, since it is usually also affected to a variable degree. On TVUS, an echogenic cyst content with surrounding Color Doppler rim may be an imaging clue.

### Conclusion

TVUS is the initial imaging modality of choice for evaluating cysts of the female reproductive system. In our opinion, CT should be reserved for oncological staging and emergency settings, where the quick availability of MR is lacking. In the case of an inconclusive TVUS, MRI is the adjunctive imaging modality of choice. Nowadays, because of limitations in tumor marker as well as in imaging specificity, some ovarian cancers will not be diagnosed preoperatively. In the future, diagnosis

may be more fine tuned using state-of-the-art MRI at 3T with dedicated coils and additional techniques such as diffusion, perfusion and spectroscopy.

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