Signs in imaging of the female pelvis: A pictorial review

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Learning objectives

To demonstrate various diagnostic signs in imaging of the female pelvis with pathologic correlation.

Background

Various diseases may occur in the female pelvis from not only reproductive organs but also intestinal, mesenteric, urinary, or extra-peritoneal organs.

Imaging findings OR Procedure details

[Signs associated with signal intensity pattern on MRI]

"Shading sign" (Fig. 1 on page  )
-Organ: Ovary
-Pathology: Endometrioma (endometrial cyst, chocolate cyst)
-Appearance/Explanation: T2-shortening in an adnexal cyst exhibiting high signal intensity on T1WI. "Shading" may appear as complete loss of signal intensity or dependent layering with a hypointense fluid level on T2WI. The cause of hypointensity on T2WI is complex; hyperviscosity, and high concentration of protein and hemosiderin from recurrent cyclical bleeding may contribute to T2-shortening. Because susceptibility-induced signal intensity loss may increase from 1.5T to 3T, the shading sign is well visualized at 3T.

"Stained-glass appearance" (Fig. 2 on page  )
-Organ: Ovary
-Pathology: Mucinous cystadenoma/adenocarcinoma, etc.
-Appearance/Explanation: Various contents in the loculi of multilocular cystic tumor show variable signal intensity on both T1- and T2WIs. Mucinous, hyperproteinous fluid, colloid, hemorrhage, fat, hyperkeratinous materials, and solid tumoral components may contribute to "Stained-glass appearance". Various primary/secondary ovarian tumors may also show this finding such as mature cystic teratoma, struma ovarii, metastasis from colon cancer, Brenner tumor (with co-existing mucinous tumors), endometrioma etc.

"Hyperintense rim sign" (Fig. 3 on page  )
-Organ: Uterus
-Pathology: Leiomyoma with red degeneration
-Appearance/Explanation: Red degeneration is hemorrhagic infarction due to venous obstruction, which is associated with pregnancy, or oral contraceptive. Characteristic "hyperintense rim sign" on T1WI corresponding to strongly paramagnetic methemoglobin within numerous dilated obstructed veins may appear at late phase of red degeneration. At early phase of red degeneration, "hyperintense rim sign" does not appear yet, however, low intense rim on T2WI corresponding to deoxyhemoglobin may be observed.

"Black sponge-like appearance" (Fig. 4 on page  )
-Organ: Ovary
-Pathology: **Cystadenofibroma**

**Appearance/Explanation:** Cystadenofibroma is a benign surface epithelial-stromal tumor. The solid portion is composed of dense fibrous tissue in which glandular structures are present. On US/CT, cystadenofibroma may appear as a non-specific solid and cystic adnexal mass mimicking malignancy. On T2WI, cystadenofibroma may show black sponge-like appearance: a fibrous low intense mass containing multiple high intensity tiny cysts reflecting glandular components.

"**Black garland-like appearance**" (Fig. 5 on page)

-Organ: Ovary

-Pathology: **Fibromatosis**

**Appearance/Explanation:** Ovarian fibromatosis is a rare benign, non-neoplastic condition with ovarian enlargement in young women affecting one or both ovaries. Ovarian fibromatosis is characterized by a proliferation of collagen-producing spindle cells surrounding normal ovarian structures. MR manifestations are fibroma-like signal intensity pattern due to fibrous stromal proliferation, and preservation of the ovarian structures within the mass. Thickened low intense fibrous stroma of cortex surrounding normal ovarian structures on T2WI as "black garland"-like appearance is characteristic, but not always observed.

"**Black rim sign**" (Fig. 6 on page)

-Organ: Peritoneal cavity

-Pathology: **Polypoid endometriosis**

**Appearance/Explanation:** Polypoid endometriosis is a rare variant of benign endometriosis forming large, often multiple polypoid masses simulating malignant tumors at operation. The morphologic appearance of polypoid endometriosis is similar to that of malignant tumors such as peritoneal dissemination. The presence of surrounding adhesive fibrous tissue showing hypointensity on T2WI as "black rim sign" suggests its origin from pelvic endometriosis.

"**Mural Othello pieces**" (Fig. 7 on page)

-Organ: Ovary

-Pathology: **Malignant Brenner tumor**

**Appearance/Explanation:** Malignant Brenner tumor contains both benign and malignant transitional cell components. Macroscopic appearance is a unilocular cystic mass with mural nodules. Combination of low intense fibrous benign nodule (Brenner tumor) and high intense malignant nodule (TCC: transitional cell carcinoma) is characteristic as "Mural Othello pieces". Benign nodule is often calcified.

[Signs associated with morphologic appearances]

"**Bridging vascular sign**" (Fig. 8 on page)

-Organ: Uterus

-Pathology: **Subserosal leiomyoma**

**Appearance/Explanation:** The bridging vascular sign is the presence of multiple curvilinear tortuous signal voids reflecting feeding vessels along the interface between the uterus and subserosal leiomyoma on MRI, and indicates the uterine origin of leiomyoma.

"**Beak sign**" (Fig. 8 on page)
- **Organ:** Uterus  
- **Pathology:** Subserosal leiomyoma, adenomyotic cyst etc.  
- **Appearance/Explanation:** Subserosal mass causes the edge of the adjacent uterus to become beak-shaped indicating its uterine origin.  

"**Preserved follicle sign**" (Fig. 9 on page )

- **Organ:** Ovary  
- **Pathology:** Benign enlarged ovaries  
- **Appearance/Explanation:** Tumor-like conditions with ovarian enlargement may be mistaken for ovarian neoplasms in clinical practice. The mechanisms of non-neoplastic ovarian enlargement are various such as: stromal proliferation with hormonal abnormality (polycystic ovaries), edematous stromal swelling (massive ovarian edema), congestion with hemorrhagic infarction (ovarian torsion) and granulation with or without abscess formation (salpingo-oophoritis). Demonstration of the preserved ovarian follicles (preserved follicle sign) serves as a diagnostic guide to differentiate these conditions from neoplasms in patients of reproductive era. However, similar finding may be observed also in ovarian small round cell tumors such as lymphoma.

"**Floating fat balls**" (Fig.10 on page )

- **Organ:** Ovary  
- **Pathology:** Mature cystic teratoma  
- **Appearance/Explanation:** Mature cystic teratoma with floating fat balls shows characteristic imaging findings. On T2-WI, the mass looks like tapioca pearl with sweet coconut milk served at ethnic cuisines. These balls consist of keratin and adipose tissue, and the mechanism of ball formation is unknown.

"**Uterine scalloping**" (Fig.11 on page )

- **Organ:** Uterus - peritoneal cavity  
- **Pathology:** Pseudomyxoma peritonei  
- **Appearance/Explanation:** Pseudomyxoma peritonei is a rare neoplastic condition caused by mucinous disseminated implants from ruptured low-grade mucinous tumors. Gelatinous fluid-like materials spread over the peritoneal cavity with characteristic organic scalloping, observed in the liver, splenic, or mesenteric margins. Localized disease in the female pelvis may simulate ovarian carcinomatous peritonitis, and scalloping uterine margin may suggest pseudomyxomaperitonei. Because synchronous mucinous tumors of the ovary and the appendix may occur, careful observation to detect occult primary appendiceal mucocele is necessary.

"**Marginal crescent sign**" (Fig.12 on page )

- **Organ:** Extra-peritoneal region  
- **Pathology:** Ancient schwannoma  
- **Appearance/Explanation:** Ancient (degenerated) schwannoma may tend to be mistaken for ovarian disease clinically, because patients are usually asymptomatic and US reveals as totally cystic, or solid and cystic masses. Pelvic schwannoma situates at presacral or lateraextra-peritoneal region with the continuity to the nerve or neural foramen. Marginal crescent-shaped solid components (Marginal crescent sign) may be observed intotally degenerated cystic masses reflecting its secondary cystic nature.
resulting in marked degeneration, and is helpful to differentiate from essentially cystic tumors.

"Target-like appearance" (Fig. 13 on page)
- **Organ:** Urethra
- **Pathology:** Urethral diverticulum/ Clear cell adenocarcinoma
- **Appearance/Explanation:** Urethral clear cell adenocarcinoma arises from urethral diverticulum or paraurethral ducts and glands, and extends to the submucosa surrounding the urethra. Advanced tumor may involve adjacent vagina, and simulate gynecologic malignancy. Preserved normal urethra within the mass as central dot on T2WI (target-like appearance) suggests its urethral origin.

"Centripetal displacement sign" (Fig. 14 on page)
- **Organ:** Extra-peritoneal region
- **Pathology:** Various non-epithelial tumors
- **Appearance/Explanation:** The location of extra-peritoneal tumors could be determined by detecting centripetal displacement of the adjacent structures (centripetal displacement sign). Anterior displacement of the compressed rectum in retroperitoneal tumors arising from the presacral tissue, and inward displacement of the compressed iliac vessels or ureter in lateral extra-peritoneal tumors are useful in determining their location.

"Black worms" (Fig. 15 on page)
- **Organ:** Uterus
- **Pathology:** Low-grade endometrial stromal sarcoma (LG-ESS)
- **Appearance/Explanation:** LG-ESS is a rare malignant mesenchymal tumor, and usually occurs in the endometrium with extensive myometrial invasion. Myometrial invasion of LG-ESS is very infiltrative, and preserved low intense muscle bundles like "blackworms" within high intense tumor on T2WI are characteristic.
"Shading sign" in Endometrioma

T1-High intense cyst exhibits Low on T2WI (shading)

Occasionally, very Low Intense

"Shading" is more prominent at 3T

Occasionally, with Hct. effects

"Shading" is T2-shortening due to hyperviscosity, high concentration of protein and hemosiderin from recurrent cyclical bleeding

Fig.
"Stained-glass appearance" in Mucinous tumors etc.

Mucinous cystadenocarcinoma (metastatic colon cancer)

Mucinous cystadenoma (Borderline malignancy)

Mucinous cystadenoma

T2-high: serous

T2-low: colloid

T2-high: hemorrhage

Brenner tumor

Struma Ovaril

T2-high: mucinous

T2-slt. low: mucinous

T1-low: serous

T2-high: serous

T2-slt. high: solid portion of carcinoma

T2-low: thick mucinous

T2-low: solid portion of Brenner tumor

CE-T1WI

CE-T1WI

T2WI

T2WI

Fig.
"Hyperintense rim sign" in Leiomyoma with Red degeneration

T1WI  T2WI  CE-T1WI

Lack of CE due to hemorrhagic infarction

Characteristic T1-high intense rim appears at late phase corresponding to met-Hb within obstructed vein

T2-low intense rim is observed at early phase corresponding to deoxy-Hb within obstructed vein

Hemorrhagic infarction due to venous obstruction, associated with pregnancy, or oral contraceptive.
"Black sponge-like appearance" in Ovarian cystadenofibroma

High intense tiny cysts scattered within Low intense mass on T2WI as "Black Sponge"-like appearance

Fibrous stroma: T2-Low

Dilated Glands

Dense fibrous stroma
"Black Garland-like appearance" in Ovarian Fibromatosis

Fibrous cortical thickening exhibits low on T2WI surrounding ovarian parenchyma with high intense preserved follicles as "Black Garland"-like appearance

Dense fibrous cortical thickening
"Black rim sign" in Polypoid endometriosis

Polypoid masses in the pouch of Douglas High intense on T2WI peripheral low intense rim as "Black rim sign" corresponds to adhesive fibrosis of peritoneal endometriosis

Fig. 6

Abundant endometrial glands in Endometrial polyp-like mass may cause High intensity on T2WI

Peripheral fibrosis

Fig.
"Mural Othello pieces" in Malignant Brenner Tumor

Benign Brenner tumor co-exists with malignant TCC

On T2WI, Unilocular cyst with
Low intense benign fibrous mural nodule (Brenner tumor)
High intense malignant mural nodule (TCC)

Calcification in benign Brenner tumor

Dense fibrous stroma (+)

Malignant component (TCC)

Benign component (Brenner tumor)
"Bridging vascular sign/Beak sign" in Subserosal uterine tumors

Subserosal leiomyoma

Subserosal degenerated leiomyoma

CE-T1WI

Subserosal adenomyotic cyst

T2WI

Bridging vascular sign: Flow voids of feeding arteries from Uterus suggesting uterine origin

Beak sign: Subserosal mass causes the edge of the adjacent uterus to become beak-shaped indicating its uterine origin

Fig.
"Preserved follicle sign" in Benign ovarian enlargement

Polycystic Ovaries

Normal Ovary

Benign Enlargement

Massive Ovarian Edema

Demonstration of the preserved ovarian follicles is helpful for the differentiation from neoplasms

T2WI

Benign pathology

T2WI

Tubo-ovarian Abscess

Fig.
"Floating fat balls" in Mature cystic teratoma

Looks like tapioca pearl with sweet coconut milk served at ethnic cuisines

These balls consist of keratin and adipose tissue
"Uterine scalloping" in Pseudomyxoma peritonei

Scalloping uterine margin is suggestive manifestation for Pseudomyxoma peritonei in localized disease in the female pelvis.

Characteristic organic scalloping by gelatinous fluid-like materials.
"Marginal crescent sign" in Ancient schwannoma

Presacral or laterally situated extra-peritoneal mass

Marginal crescent-shaped solid components (Marginal crescent sign) in totally degenerated cystic mass, which is distinguishable from essentially cystic tumors

Crescent portion: High on T2WI/Low on T1WI/CE(++)
"Target-like appearance" in Urethral diverticulum/ Clear cell carcinoma

High intense mass surrounding the Urethra on T2WI

Target-like appearance consists of Low intense outer muscle layer, High intense mass, and preserved normal urethra as Low intense central dot on T2WI
"Centripetal displacement sign" in Extra-peritoneal pathologies

Fig. 14

Anterior displacement of the Rectum

Inward displacement of the iliac vessels
"Black worms" in Low-grade endometrial stromal sarcoma

Fine muscle bandes are well visualized as "black worms" on High resolution T2WI at 3T

Fig. 15

Preserved low intense muscle bundles like "black worms" within high intense tumor on T2WI
Conclusion

Diagnostic signs in imaging are helpful for the differential diagnosis in the routine clinical practice, and recognition of characteristic signs in imaging may form an important part of the training process for diagnostic radiologist.

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