MRI of female pelvis as an atlas of image

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Learning objectives

- To show the protocol of female pelvic MRI in our service

- To know the radiologic features of a healthy female pelvis and to identify the main pathologic features
Background

In the last years, the MRI has become a technique of choice in the diagnostic of the female pelvis pathology because enables us to value the female genitourinary system clearer than the rest of techniques used up to now. In determinate process, like the cervix neoplasm this is the choice technique.

The pelvic patology is classified following its etiology as an inflammatory-infeccious process, neoplasm and miscellaneous ( hormonal process usually)

We relate the pathologic features observed in the studies of pelvic female MRI with its pathologic correlation: inflammatory pelvic disease, endometriosis, fibroids, benign and malignant neoplasm of the ovary, cervix neoplasm and cyst of genital system..

We have checked the pelvis female MRI performed in women, in our service over the last two years and we identify the main pathologic features.

The studies were done with a model of 1.5T. We have achieved one dose of intravenous gadolinium . The sequences performed were : single shot T2weighted in the coronal plane, TSE T2 weighted sagital, TSE T2 weighted with fat suppression in the axial plane, T1 weighted with fat suppression 3D without and after the injection of gadolinium and diffusion weighted in axial plane. We do not use endovaginal gel in the study of the genital system.
ZONAL ANATOMY OF UTERUS

The optimal sequences for the study of uterus are the sagital TSE T2w. The body of uterus has three very different zones. The endometrium is usually observed hyperintense in T2w, the union zone is hipointense in T2w and the myometrium which is usually observed like an intermediate signal.

BENIGN NEOPLASM OF UTERUS: FIBROIDS

They represent the gynecologic benign neoplasm more frequent and might achieve approximately 50% of the female population in fertile age. They present a low mortality but an elevated morbility, found between one third and two third of the all hysterectomies performed.

The useful sequences are T2w, observed as a hypointense mass well defined in the submucous, subserous or intramural location Fig. 2 on page 9.

The fibroid might suffers various degeneration processes like fat degeneration, cellular degeneration, red, mixoyd o sarcomatous. In this case its appearance changes and looks like masses of heterogeneous signal in T2w. The only way to distinguish them is by resection and pathologic study because all of them behave in a similar way Fig. 3 on page 10.

The MRI is currently the chosen technique as a previous study to the uterine artery embolization in order to confirm the success of the process and then to achieve the consecutive monitoring.

The factors associated to a good response are the submucous location, a low contribution of the uterine artery and the hypervascularization of the neoplasm. In the postembolization studies we will value the existence of hemorrhagic infarct which is the best predictor of response observed in the T1w sequences with fat saturation as a hyperintense area. Another factor of good response is the absence of enhancement after the administration of gadolinium Fig. 4 on page 11 Fig. 5 on page 12.

2- MALIGN PATHOLOGY OF UTERUS:

ENDOMETRIUM CARCINOMA

The carcinoma of endometrium is an illness usually observed in postmenopausical women. The more common histologic form is the endometrioid carcinoma which represents the 80% of all the tumors. It is associated with other tumors, increasing the risk of sincronic or metacronic breast, ovary or colon tumors.
The classification more use is the FIGO system. Table 1 on page 13

The more useful sequences for its study are the T1 w fat saturation 3 D before and after the administration of gadolinium, with three phases: arterial, venous and delayed. This let to realize the staging based on the invasion degree. Table 2 on page 14

The early phase let us distinguish between the staging Ia to Ib. The balance phase occurs in the two-three minutes after the inyection of contrast and distinguishes the staging Ib and lc. Finally, the delayed phase let to know the cervical stroma invasion. Fig. 6 on page 14 Fig. 7 on page 15

2- CORIOCARCINOMA

The coriocarcinoma is originated in a 50% from the hydatidic mola, in a 25% from detain abortation or ectopic pregnancy and another 25% from normal pregnancy.

It is a very invasive neoplasm with extensive necrosis and bleeding areas, so we can observe it as iso or hyperintense masses in the sequence T1w. After the administration of gadolinium we observe a heterogeneous mass with necrotic center, peripheral enhancement and myometrial invasion. Fig. 8 on page 16

3- CARCINOMA OF CERVIX

The uterine cervix is composed by the portio, which protudes into the vagina and the supravaginal part.

Histology there are three layers, the epihelial surface, with two types of epitelium, the squamous epithelium ( covers the epihelial surface of the portio to the vagina) and the glandular epithelium of the endocervical gland, formed by columnar cells. With age, squamous cells grow back to cover the columnar cells ( transitional area). At this location the carcinoma originates the most of time.

The clinic staging more usual is the FIGO Table 3 on page 17.

In MRI they appear as hyperintense masses on T2-weighted images . The use of the dynamic sequences T1-w with contrast is useful for diagnosing parametrial invasion. The urography sequences enable us to know the ureter invasion Table 4 on page 18

It is very important to value if it affects only the cervix, or if there are invasion of vagina, parametria, wall pelvis, ureter, bladder or rectum. The existence of nodes is also important. Fig. 9 on page 18 Fig. 10 on page 19.

Fig. 12 on page 21. Fig. 13 on page 22

4- BENIGN PATHOLOGY OF CERVIX

NABOTHIAN CYST
They are common retention cysts of the uterine cervix. They are formed by chronic cervicitis. They are usually a few millimeters long and they are often seen as incidental findings at MR. They have intermediate or slightly high signal on T1-w and a prominent high signal in T2-w. Fig. 14 on page 23

5- INFLAMMATORY PATHOLOGY OF PELVIS : PELVIC INFLAMMATORY DISEASE

The abscess of salpinx and ovaries are inflammatory lessions which arise from a pelvic inflammatory disease or eventually they have iatrogenic origin. The microorganism more frequent are Chlamydia and Neisseria gonorrhoeae.

The factors of risk are the use of intrauterine dispositives and the sexual promiscuity.

In MRI, we see them like cystic lesions with hyperintense signal in T2w, with parietal thickness and perilesional enhance. In diffusion w they have a restriction. Fig. 15 on page 24 Fig. 16 on page 25

6- OVARIc PATHOLOGY

In the pathology of the ovaries it is important if the lesion is cystic, solid and cystic or only solid, also if there are one cyst or more and the kind of the signal.

The features that will increase the risk of malignant lesion are :

- Solid mass or mass with a predominant solid component (this last feature mainly )
- Parietal thick of more of 3mm
- Thick septal or intramural nodes
- Necrosis

The lesions only cystic are in the most of cases, benign, with exception of the borderline tumors.

UNILLOCULAR CYST

The unillocular cysts are the most frequent lesions , they appear in young women an they are benign in the most of cases.

The functional cysts ( follicular cysts or luteus corpus cysts) are hipointense in T1w and hiperintense en T2w if they are not complicated. Fig. 17 on page 26

- The paraovaric cyst which proceed from the mesonefro are also unilocular
- hydro-hematosalpinx in the context of endometriosis is observed like a round or oval unillocular cyst. If the main component is blood ( hematosalpinx) there is a hyperintense
signal in sequences T1-w, and a signal less hyperintense than the liquid in T2-w Fig. 18 on page 27 Fig. 19 on page 28

- Serous cystoadenoma is a benign lesion of the ovary usually seen like a large hyperintense lesion in T2w without enhancement after the injection of contrast. Fig. 20 on page 29

MULTILLOCULATED CYST

- The multiloculated cyst are usually endometriosic cyst, mucinous cystoadenoma, cystic mucinous tumor and borderline neoplasm.

SOLID LESIONS

The purely solid lesions are usually benign: fibroatecomas or mature cystic teratoma, although there is malign tumors as neoplasm of the granulosa or dysgerminomas of ovary that usually are solids. Disgerminoma is frequent in women with less of 30 years old.

The fibrothecoma is the most common solid benign tumors of the ovary and show low signal on T2-weighted images and intermediate signal in T1-weighthed. The differential diagnosis have to do with subserous leiomyomas.

The Brenner tumor tipically shows a low signal intensity in T2-weighted, lower than the fibrothecomas. It is associated frecquently with mucinous cystic tumors in the same ovary.

- The epithelial carcinoma of ovary , although less frecquently , can be observed as a pure solid lession. The metastasic tumors usually are predominantly solids ( tumor of Krukenberg), and proceed more often from tumors of gastrointestinal system ( signet ring carcinoma of stomach)

MIXED LESIONS

The mixed lesions( cystic and solid ) are usually malign , except the cystic mature teratoma of the ovary. They increase the Ca 125 and their histology more usually are the serous cistoadenocarcinoma ( almost all of the cases are disseminated in the moment of the diagnostic ). The mucinous cistoadenocarcinoma is less frequent , and it is in a lower stage at the moment of the diagnostic ( usually in a stage I ).The endometrioid carcinoma is the second in frequency ant it is associated to endometriosis.

ENDOMETRIOSIS

The endometriosis is the presence of endometrial glands and stroma out of the endometrium, with cyclic blood. The location more frecquent is the ovary and in the salpinx.
The endometrioma is observed in MRI typically like a hyperintense lesion in T1w and T2 w, with parietal thick and areas of lower signal in T2 w which are attributed to cyclic deposit of products of the blood. The differential diagnosis is made with other hyperintense in T1 weighted cysts, as the cyst of corpus luteum (unilocular), dermoid cyst (tipically lost his signal with the fat saturation), mucinous neoplasm (less hiperintense that the endometriosic cysts) and blood neoplasm. Fig. 21 on page 30 Fig. 22 on page 31

When we are in front of an atypical endometriosic cyst, it is very important that we descart a malignization, usually towards endometrioid carcinoma. This is a cystic hyperintense in T1 and T2 with mural nodes that enhance with contrast. Fig. 23 on page 31 Fig. 24 on page 32

**CYSTIC TERATOMA**

The cystic teratoma is a frequent tumor (until 20% of adnexal neoplasm in adult female and until 50% in children). They proceed of the three germinal layers. The more usual imaging is a lesion with mixed liquid and fat content, although it is possible to find other forms as purely cystic lesions with very poor fat component, purely fat lesions without other component (hair or teeth). The existence of areas of enhancement inside the tumor is frequent in the combined tumor, like the germinal cells tumor.

The cystic teratoma is a collision tumor with the mucinous cystoadenoma or the cystoadenocarcinoma, in this case we observe a cystic multiloculated mass with an internal part of fat.

The complications more usually of this tumor are the torsion, the infection and the rupture. The adnexial torsion is observed like a parietal asimetric thickness of the ovary with higher density of surrounded fat.

The malignization is very rare, in 1-2%. It is more usual in postmenopausal women and the histologic form is usually the scamous cells carcinoma that arises from the Rokitansky’s nodes. The imaging is a lesion with irregular parietal thick with extension to another neighbours organs and with enhancement of the Rokitansky’s node. It is usual high nivels of alphafetoprotein. Fig. 25 on page 33 Fig. 26 on page 34 Fig. 27 on page 35
Images for this section:

Fig. 1

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Fig. 2: Sagital TSE T2w. In the corpus of uterus there is two hypointense and intramural lesions and one hypointense lesion in the fundus uterine, subserous.

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Fig. 3: Fundic degenerated fibroid. There is a heterogeneous mass in the fundus with hyperintense and hypointense areas inside. It is difficult to differ the type of degeneration with imaging methods.

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**Fig. 4:** Embolized fibroid in the T1w with fat saturation without contrast. There is some areas of high signal inside the fibroid. They represent hemorrhagic transformation.

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Fig. 5: T1w with fat saturation post gadolinium. There is not enhancement of the fibroid. The embolization was successful.

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**Table 1:** CLASSIFICATION OF THE FIGO AND TNM STAGING OF ENDOMETRIUM CARCINOMA

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**MRI STAGING OF ENDOMETRIUM CARCINOMA**

I: CONFINED TO BODY

IA: LIMITED TO ENDOMETRIUM . Enhancement subendometrial in band

IB: INVASION OF LESS 50% OF MYOMETRIUM: irregular thick in the interphase myometrium-neoplasm.

IC: DEEP INVASION MYOMETRIAL

II: INVASION OF CERVIX

IIA: ENDOCERVIX: widening of the endocervix with normal signal of the cervical stroma

IIB: CERVICAL STROMA: hyperintense in T2w

III: OUTSIDE OF UTERUS

IIIA: PARAMETRIA: serous disrupted with extension to parametrial fat

IIIB: THIRD UPPER OF VAGINA: loss of the normal hypointense signal in the wall of vagina

IIIC: NODES

IV: METASTASIS:

IVA: BLADDER, RECTUM

IVB: DISTANCE

**Table 2:** STAGING BY MRI OF ENDOMETRIUM CARCINOMA

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Fig. 6: Carcinoma of endometrium stage IIIb: mass in pelvis with distortion of the normal architecture of the uterus and extension to parametria and upper third of vagina.

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**Fig. 7:** The same example of the Fig 7. There is a mass in pelvis which involves the right ureter. There was right hydronephrosis (not showed)

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**Fig. 8:** Coriocarcinoma. There is an enlargement of the junction zone and the myometrium of posterior side of uterus with increase of signal that represents myometrial invasion.

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### Table 3: STAGE OF CERVIX CARCINOMA (FIGO)

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<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA: CARCINOMA IN SITU</td>
<td>Only histopathologic confirmation</td>
</tr>
</tbody>
</table>
| IB: LIMITED TO CERVIX | IB1: LESS OR EQUAL TO 4 CM  
| | IB2: MORE OF 4 CM |
| II: UPPER THIRD OF VAGINA | IIA: WITHOUT INVASION OF PARAMETRIA  
| | IIB: WITH PARAMETRICAL INVASION |
| III: LOWER THIRD OF VAGINA | IIIA: LOWER THIRD OF VAGINA  
| | IIIB: WALL OF PELVIS OR URETER (HYDRONEPHROSIS) |
| IV: METASTASIS | IVA: BLADDER, RECTUM OR MORE THE TRUE PELVIS WALL  
| | IVB: DISTANCE |

### Table 4: MRI STAGING OF CERVIX CARCINOMA

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<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 0: Carcinoma in situ</td>
<td>Not visible in imaging</td>
</tr>
</tbody>
</table>
| Stage I: confined to cervix | IA: microscopic usually not visible. In Ia (>3mm) there is often a small enhancing of the tumor  
| | IB: tumor visible with intact stromal ring surrounding it |
| Stage II: beyond uterus | IIA: disruption of low signal intensity vaginal wall (upper two-thirds). There is no parametrial invasion  
| | IIb: complete disruption of stromal ring with tumor extending into the parametrium |
| Stage III: extension to lower one-third of vagina or pelvic wall invasion with hydronephrosis | IIIa: invasion of lower one-third of vagina  
| | IIIb: pelvic muscles or ureter |
| Stage IV: outside the pelvis | IVA: loss of low signal intensity in bladder or rectal wall  
| | IVB: distant metastasis |
Fig. 9: Cervix carcinoma stage Ib: mass hyperintense in T2w which arise of the cervix, without affection of parametria or vagina.

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**Fig. 10:** Stage IIb: hyperintense mass in T2w in cervix that extends to upper third of vagina and with parametrial invasion

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Fig. 11: Cervix carcinoma stage IVa: hydronephrosis in both kidneys

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Fig. 12: Stage IVa: invasion of wall of bladder and rectum

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Fig. 13: Cervix carcinoma stage IVa: invasion of wall of bladder

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Fig. 14: Nabothian cyst: There is a little lesion of few millimeters in the cervix with high signal in T2-w

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**Fig. 15:** Pelvic abscess (pelvic inflammatory disease). Heterogeneous mass with cysts with high signal in T2-w. There is a restriction of diffusion (in the next figure).

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**Fig. 16:** Pelvic abscess: in the left side of pelvis there is a heterogeneous mass with areas of restriction of diffusion. She is the same patient that the fig 15

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**Fig. 17:** Functional cysts: Much lesions in the right ovary, hyperintense in T2-w

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Fig. 18: Hematosalpinx in a patient with endometriosis. There is a large cyst with less signal than liquid in the anexus.

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**Fig. 19:** The same patient that fig 18. In T1-w there is a large mass hyperintense (metahemoglobin)
Fig. 20: Serous Cystadenoma. There is a large unilocular cyst in pelvis that does not enhance after the administration of gadolinium

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**Fig. 21:** Endometriotic cyst: Two lesions in right ovary with high signal in T1-weighted with fat saturation.

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**Fig. 22:** Endometriotic cyst: In T2-weighted there is two masses in right ovary with low signal intensity (the same patient than fig 21)

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Fig. 23: Endometrioid carcinoma of ovary. In a woman with previous history of endometriosis we observed a heterogeneous mass with areas of high signal in T2 and parietal nodes that enhance with contrast. The histology of the lesion was endometrioid carcinoma.

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Fig. 24: Endometrioid carcinoma. There is an heterogeneous enhancement of the lesion in left ovary, predominantly in the mural nodes.

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Fig. 25: TSE T2w. Cystic teratoma There is a lesion in pelvis with intensity like fat and a hypointense parietal node.

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Fig. 26: Cystic teratoma. Sequence T2w with fat saturation. There is a cystic lesion with liquid-fat level in the pelvis.

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Fig. 27: The same patient that 25 and 26. The lesion do not enhance after gadolinium. In the dynamic sequence GE 3d T1w with fat suppression we observed a strong hypointensity of the upper component of cyst for the fat component.
Conclusion

The MRI is a very useful instrument in the diagnosis of many processes that affect the female pelvis and it makes possible to identify the etiology and the extension of the process. Also it provides the surgeon with valuable features for the therapeutic planning.

The gynaecological pathology is very usual, and the radiologist must know in detail the features of these processes as we are usually consulted.
Personal Information

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