AKADEMIJA NAUKA I UMJETNOSTI BOSNE I HERCEGOVINE
АКАДЕМИЈА НАУКА И УМЈЕТНОСТИ БОСНЕ И ХЕРЦЕГОВИНЕ
ACADEMY OF SCIENCES AND ARTS OF BOSNIA AND HERZEGOVINA

RADOVI

KNJIGA XCIII

Odjeljenje medicinskih nauka

Knjiga 33

Centar za medicinska istraživanja

Knjiga 3

SARAJEVO 2004

MRI IN DIAGNOSTIC OF THE FEMALE PELVIS MALIGNANCIES: FIVE YEAR PERIOD EXPERIENCES.

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Abstract

The purpose of this study was to assess diagnostic accuracy of MRI in differentiation of female pelvis disorders. We compared our results with clinical staging and post operative findings.

Method and Material: During the five year period we performed MRI of the female pelvis at 225 patients. Average age of patients was 42. In 92 (36%) patients, MRI revealed ovarian malignancy, in 61 (24%) patients uterine carcinomas, in 54 (24%) recto-sigmoid tumors – Krukenberg and the other 18 (8%) patients had non malignant diseases of pelvis.

All patients were examined on MR 1,0 T units, with body coil: axial, sagittal and sometimes coronal planes T2 WI TSE and T1 WI SE sequences were used. If it was necessary contrast medium – gadolinium was injected intravenously during T1WI SE sequences, and FAT SAT, when needed.

Results: In our reports we compared MRI results with clinical staging (gynecological examination, TAUS sometimes TVUS, CT) and post operative findings, with sensitivity 89 % and specifity 76 %.

Conclusion: As we know from the literature the most authors consider that MRI today is the method of choice in the staging of pelvis malignancy, with exception of staging of ovarian malignancy, were CT is the preferred method.

Key words: female pelvis, disease, malignancy, uterus, ovary, MRI.

Introduction

Rapid advances in technology over two decades, including the introduction of computed tomography (CT), magnetic resonance imaging (MRI) and improvement of ultrasound (US) technique, have resulted in significant changes in diagnostic imaging of the pelvis. Although, US is still considered an excellent screening technique for benign pelvic disease (1,2) US technique has technical limitations (caused by the patient's habitus, operator dependence) and lacks the capacity to provide specific tissue characterization. US is inadequate for staging of pelvis malignancies (2,3). CT represents a technical advance over US for staging of pelvic neoplasms, but degradation of information (because of the relative lack of soft tissue contrast resolution) detracts from its usefulness (4).

Additional drawbacks to CT for staging of neoplasms include the limitation to only the transverse plane of imaging, the necessity for injection of the contrast material, with its attendant potentional dangers, and exposure of the tissue to ionizing radiation (3,4).

MRI is likely to remain the initial procedure for evaluating clinically suspected pelvic masses in women (1-3). MRI however is going to be supplement for CT in near future and play an important role in evaluating patients for whom US findings are suboptimal, patients in whom the origin of the pelvic mass cannot be determined with US, and patients in whom differentiation between simple fluid lesions and other types of adnexal lesions is not possible with US (5-6).

Most important, MRI will play a significant role in the staging of pelvic neoplasms (6-10).

The aim of this investigation is to review the contribution of MRI as a method of choice in detecting and staging of female pelvis disease, as well as to evaluate the diagnostic possibilities of MRI 1,0 T at our Institute.

Material and method

At our Institute of Radiology we did retrospective analysis of MR imaging of female pelvis performed during the period from 1998 to 2004. Examination of female pelvis has been performed at 225 patients because of the suspicion for existing malignant disease or control in the follow up after the conduction the oncology therapy. Average age of the examined patients was 42. From 225 patients with suspicion for pelvis malignancy at 153 patient's examination was done because of the uterus and ovary malignancy, at 72 patients it was for recto-sigmoid malignancy, at 18 patients malignancy was not found, but disease of genital organs of other etiology was confirmed.

When we are planning to assess uterine body, cervix and vagina both sagittal and transverse imaging planes are required. T2 –weighted scans display the characteristic zonal anatomy, with three distinct areas within uterine body. There is hyperintense central zone representing the endometrium combined with secretions into the endometrial canal, an outer area of intermediate signal due to myometrium, and low- signal junctional zone between, from a layer of compressed myometrium (figure 1.).

Changes in size and sagittal signal intensity of the three zones in uterus occur during the menstrual cycle, with an increase in volume and signal of the myometrium in the secretory phase. Following intravenous Gadolinium – enhance the endometrium and myometrium, with junctional zone remaining low – signal on T1 weighted images.

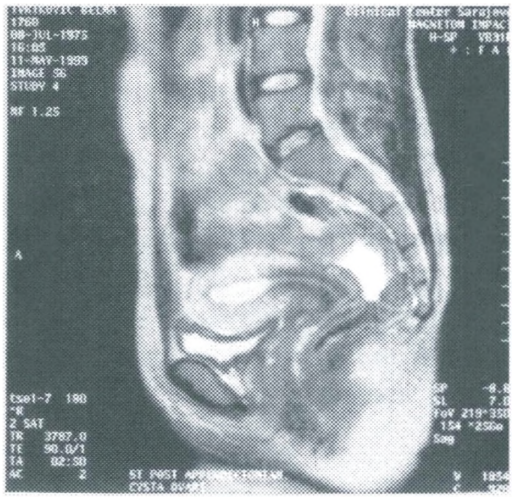

Figure 1. Hyperintense central zone representing endometrial sagittal plane

The cervix is a cylindrical-shaped structure measuring 2-4 cm in length, connecting with the body at the level of isthmus. The isthmus uteri is approximately at the peritoneal reflecting point on the bladder. The cervix has two distinct layers: a hyperintense central zone representing cervical mucus and epithelium, with an outer zone of low signal, similar to the uterine junctional zone, due to the fibrostromal wall. A further peripheral layer of intermediate signal may be seen continuous with the myometrium. The parametrium have an intermediate signal on T1 weighted images, with increase in signal on T2 weighted scans. After injection of gadolinium the compact cervical stroma retains its low signal, with enhancement of the paracervical tissue and inner cervical epithelium on T1 weighted images. There are numerous glands lining the cervical canal and ducts of these glands can become blocked, producing retention (Nabothian) cysts. These are commonly seen on MRI of the female pelvis.

The vagina can be identified as a high-signal central zone of mucus and epithelium surrounded by a low-signal muscular wall. The vagina can be divided into three regions: an upper third is characteristic by the lateral vaginal fornices, a middle third is at the level of the bladder base, and a lower third is at the level of the urethra. There is a high signal venous plexus surrounding the cervix and vagina, best seen on transverse T2 weighted images.

The normal - sized ovaries are best-demonstrated on transverse or coronal scans, and can be identified in 96% of women during the reproductive age. They measure 1,5 – 3 cm in diameter and have a variable signal on T1-T2 weighted images. The premenopausal ovary shows a low intermediate signal, similar to muscle, on T1 weighed images. This appearance is altered if there is a hemorrhage present. On T2 weighted scans the ovary is usually of low signal, but it can be of high signal in

some individuals. The cause of this high signal is unknown but it probably due to a looser vascular and connective tissue in the medulla of the ovary. On high resolution T2 weighted imaging, numerous small peripheral cysts (follicles) are seen, with a more intermediate high signal from the central stroma of the ovary (figure 2a, 2b, 2c). On T1 weighted images, difficulties can occur in identifying the ovaries separate from adjacent bowel and uterus. The use of bowel specific oral contrast agents can be of help in this regard. After intravenous injection of gadolinium the normal ovaries enhance, allowing improved detection of non-enhancing follicular cysts. The ovaries lie in the adnexa lateral to the uterus, maintaining a constant relationship with the pelvic urether.

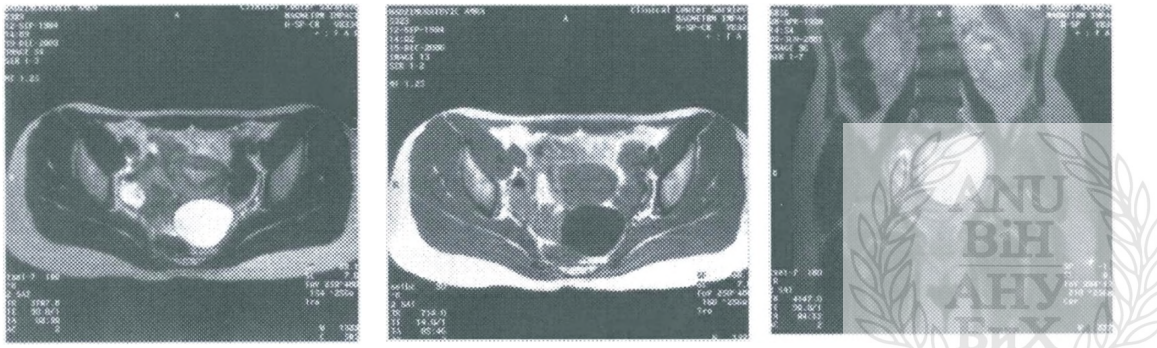

Figure 2a, 2b, 2c: Axial and coronal planes of ovarian cysts on T1WI and T2WI

Based on standard protocol we performed certain cross sections in transversal, sagittal and coronal planes, using T2 TSE (TR 3500 ms, TE 90 ms, FOV 350, matrix 182 x 256 mm) and T1 SE (TR 600ms, TE 14 ms, FOV 400, matrix 196 x 256), sequences with slice thickness of 4 mm. Usually there is no need for special preparations prior examination.

Results

All of our female patients had beside clinical findings, diagnosis of pelvic malignancy established with on of the imaging techniques (CT or US) and we tried to confirm or exclude the given diagnosis. In the figure 1. distribution of MR established diagnosis was given from our material collected during five years, in compression with other two imaging methods.

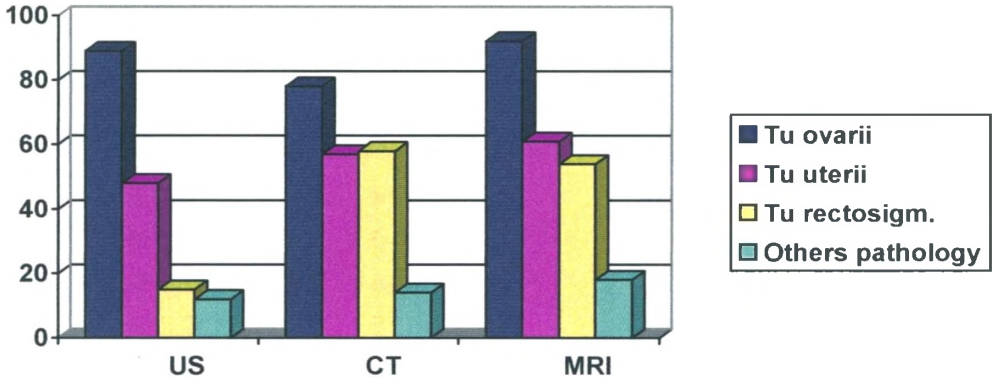

Figure 1. Frequency of the pathology of the female pelvis US, CT and MR

In table 1. Highest percentage of patients examined with MRI was ovarian TU.

Table 1. Percentage and frequency of the pathology of the female pelvis on MRI

Disease	Number	percentage
Ovarian tumors	92	36 %
Uterine tumors	61	24 %
Rectosigm. Tu	54	24 %
Others pathology	18	8 %

According to MRI the following ovarian pathology was represented, and can be seen in the table 2.

Table 2. Frequency of ovarian disease on MRI

Ovarian disease	number	percentage
Ovarian Adenocarcinoma	28	12,5 %
Ovarian cysts	21	9,3 %
Adenocarcinoma control after operation	18	6,6 %
Ovarian Cystadenocarcinoma	4	1,7%
Ovarian Dysgerminoma	3	1,3 %
Ovarian dermoid cysts	6	2,6 %
Abscess tuboovarii	5	2,2 %
Tu rectosigm.-Krukenberg's Tu	6	2,6 %

Percentage and frequency of the uterus diseases on MRI are brought on table 3.

Table 3. Percentage and frequency of the uterus disease on MRI

Uterine disease	number	percentage
Endometrial carcinoma	18	8 %
Cervical carcinoma	27	12 %
Uterine leiomyoma	14	6,2%
Artesia of vagina	2	0,2%
Uterine and ovarian varices	1	0,4%

In comparison of MRI findings with operative results we found 21 false negative findings, 9 false positive findings, 165 right positive and 29 right negative findings, which gives the specifity of the methods of 76% and sensitivity of 89%.

The figure 2, shows the rate of MRI and operative findings, comparing false positive, false negative, right positive and right negative results.

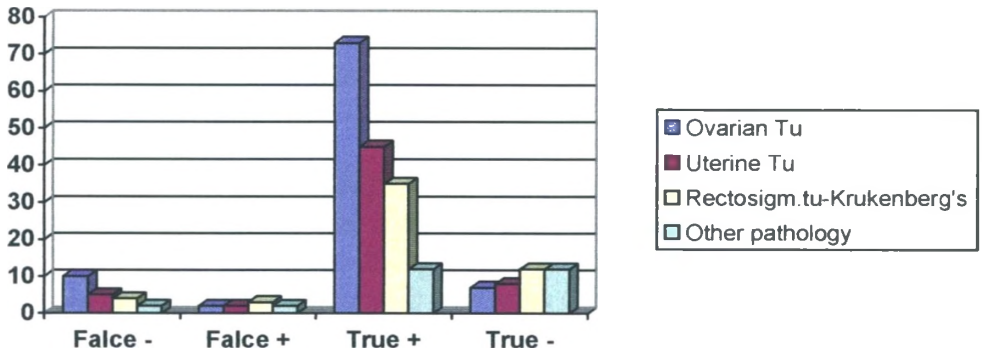

Figure 2. Rate of MRI and operative findings compared to accuracy

From the figure 2. we can see that ovarian TU specificity of the method was 78% and sensitivity 88%. For TU uteri (corpus and cervix) sensitivity of the method was 90%, and specificity 80%, for TU of recto - sigmoid colon Krucenberg's TU sensitivity of the method was 89% and specificity 80%. Finally in making the diagnosis of other female pelvic disease in 18 cases, specificity was 80 % and sensitivity was 85%.

Discussion

MRI has certain advantages in comparison with other imaging modalities: it is non invasive, non ionizing diagnostic method with possibilities of gaining the multiplane images (1,2,and 3). Except this it gives extraordinary tissue characterization possibilities. Limitations are already well known, like claustrophobia, metal foreign bodies, pace maker and metal implants.

MRI is the technique of choice in assessment and evaluation of congenital uterine anomalies. MRI can demonstrate unicornuate, bicornuate, and septate uteri, and uterine didelphus (9). In our materials we had two patients with atresio of vagina.

Uterine tumors like leiomyoma are the most solid uterine tumors, being single or multiple. These tumors are composed of smooth muscle with varying amounts of fibrous tissue, and occur in 20-30 % premenopausal women. They are located in the submucosal, intramural and subserosal spaces of uterus (10,11,and 12).

Rarely they can occur along the broad ligament or be entirely separate from the uterus. Submucosal tumors project into the endometrial cavity, and intramural

lesions arise within the miometrium. Subserosal leiomyomas occur along the serosal surface of the uterus. MRI provides an accurate assessment of the site, size and number of uterine leiomyomas. Non degenerative leiomyomas have characteristic uniform signal intensity, being indistinguishable from myometrium on T1 weighted images, with a lower signal on T2 weighted scans.

Occasionally calcification within these tumors produces a low signal on all pulse sequences. Degenerating tumors show a variable and non specific signal appearance with an intermediate high signal on T1 weighted and a high signal on T2 weighted images. Malignant transformation cannot be differentiated from benign degenerating tumors. In our material we had 14 or 6,2 % patients with leiomyomas, mainly large tumors.

Today FIGO classification for cervical carcinoma is based primarily on clinical findings, it should be noted that MRI and CT were not included as part of the staging classification. Current MRI usage is limited in stage I, but if we use pelvic phased –array and / or endovaginal or endorectal coil technique with improved resolution, and with contrast enhancement, it should allow greater precision in measuring the depth of penetration of tumor into the cervical wall (15).

Carcinoma confined within the cervix but with >5 mm depth of invasion or >7 mm in breadth (FIGO stage IB) can be demonstrated on MRI. Tumor volume is an important prognostic factor in stage I disease. Patients in early stage IB disease may have a survival of > 90%, which reduces to 50-60 % or less for patients with bulky disease. This invasive cervical carcinoma is better demonstrated on MRI than CT and appears as an area of high signal, contrasted against the low signal cervical stroma on T2 weighted images. The cervix may enlarge, leading to obstruction of the endometrial canal with distension of the uterus from retained secretions. In FIGO II disease the tumor disease extends beyond the cervix. In stage IIA the tumor extends into the upper two-thirds of the vagina but not into the parametrium and stage IIB disease extends into the parametrium but not to the pelvic side wall. The reported accuracy of MRI in the demonstration of parametrical or vaginal spread is approximately 70-90%. On MRI T2 weighted images extension into the parametrium is identified by the high signal tumor breaching the low signal cervical stoma wall on transverse, or transverse-oblique sections paralleling the short axis of the cervix. Vaginal extension is indicated on MRI by high signal tumor replacing the normal low-signal vaginal wall. In FIGO III there is extension into the lower third of vagina, or pelvic side-wall, with or without hydronephrosis. MRI criteria for pelvic side –wall invasion includes tumor within 1 cm of the mucosal of the pelvic wall, vascular encasement or high – signal tumor replacement of low signal adjacent muscles. Overstaging of tumors can again occur due to surrounding edema or inflammatory change. In stage FIGO IV disease the tumor extends outside the

reproductive tract, with tumor involvement of the mucosa of the rectum or bladder (IVA) or disease outside the true pelvis or give distant metastases (IVB). Sagittal and transverse T2 weighted scans allow assessment of tumor infiltration into the lower uterine segment, bladder, rectum and vagina, were high-signal tumor replaces the normal low signal structures. Our patients with cervical carcinomas, 27(12%) of them were in stage IIB and higher. Analysis has been done to follow the efficiency of the radioteraphy. But so far, in practice patients are mainly evaluated by CT.

In our paper we were not analyzing the lymph node status, but the presence or absence of pelvic lymphadenopathy should be assessed on the T1 weighted images, with nodes greater than 7-10 mm in diameter being considered abnormal (12).

Similar signal intensity appearances are, however, obtained from hyperplastic and metastasis in nodes. A new MRI lymphography contrast is now available using ultra small iron oxide particles (USPIO), which accumulates in normal nodes, producing a signal void while sparing metastasis in nodes, who retain their abnormal signal. The use of this contrast agent will increase the accuracy in the detection of nodal disease irrespective of size or anatomical distribution.

Endometrial carcinoma is the most prevalent invasive malignancy of the female genital tract in the USA. There has been increase in the incidence of endometrial carcinoma over the last 30 years. In the UK this tumor is second in prevalence to ovarian malignancy. On MRI endometrial carcinoma shows a signal intensity appearance similar to normal endometrium, which can cause difficulty in defining small lesions. Large lesions expand the endometrial cavity, and can have a low signal on T2 weighted images. Widening or signal heterogenicity on T2 weighted images within the endometrial canal may be the only abnormal finding in early stage of disease. The most reliable criteria for the diagnosis of myometral invasion is disruption of the junctional zone (16). Following intravenous gadolinium enhances the endometrial carcinoma, increasing the contrast difference between tumor and normal endometrium and improving the conspicuity of smaller lesions. Staging of endometrial carcinomas is important in defining appropriate treatment, which is primarily surgical with or without pelvic radiotherapy. MRI cannot provide a histological diagnosis and is not indicated unless a positive histology has been obtained. The overall reported accuracy for MRI in staging is 85 – 92 % (17). MRI is indicated in those patients in whom physical examination is difficult and there is a clinical suspicion of advanced disease, those who are unsuitable for surgical staging, or if the tumor is of high grade. In our paper we had 18 (8%) patients with very advanced disease.

Dermoid cysts are usually diagnosed on US. When additional information is required CT or MRI can be helpful. Dermoid cysts and hemorrhagic adnexal masses

show a similar MRI appearance, with a high signal on T1 weighted images and variable signal on T2 weighted scans. A frequency – selective fat suppressed sequences are useful in differentiating a hemorrhagic lesion from a dermoid cyst. From our patients 6 (2,6%) of them had a big mass. In two of them we found a very big mass which was growing outside from the pelvis.

Cystadenoma and cystadenocarcinoma can be difficult to distinguish unless lymphadenopathy, ascites or metastases are evident. The signal intensity appearance is dependent on the amount of solid and cystic tissue present (20,21). MRI is useful in defining and separating a uterine from an ovarian mass when US is equivocal. In our paper we had 92 (36%) patients with ovarian tumors, and 53 (24%) of all had advanced malignant ovarian tumors.

Conclusion

Conclusions are made based on our five year experience and the presented facts from the literature. Certainly we can say this imaging modality has its valuable place in diagnostic of female pelvis. When with US, as a method we won't be able to reach the final diagnosis, MRI in diagnostics of the anomalies and the staging of uterus malignancies will be the method of choice, the problem solving modality.

So far CT is much safer method in staging of ovary Ca and also it is more sensitive in the detection of mesenteric and peritoneal metastasis.

Apstrakt

MRI U DIJAGNOSTICI MALIGNOMA ŽENSKE ZDJELICE (PETOGODIŠNJE ISKUSTVO)

Cilj ovog rada bio je procijeniti dijagnostičku mogućnost MRI u diferenciranju oboljenja ženske zdjelice.Usporedili smo naše rezultate sa kliničkin stagingom i postoperativnim nalazom.

Metod i materijal: Tokom pet godina MRI zdjelice učinjen je kod 225 pacijentica.Prosječna starost je bila 42 godine. Kod 92 (36%) pacijentice ustanovljen je malignitet ovarija, u 61 (24 %) je bio karcinom uterusa,a u 54 (24 %) pacijentice je ustanovljen tumor rektosigmiodnog kolona – Krukenberg i 18 (8%) pacijentica su imale oboljenje zdjelice koje nije bilo maligno. Sve pacijentice su pregledane na MR aparatu od 1,0 T , sa zavojnicom za tijelo: koristili smo aksialne,sagitalne ponekad koronalne projekcije,uz T2WI TSE i T1WI SE sekvence.Kad je to bilo neophodno,intravenzno se dalo kontrastno sredstvo – gadoliniuim .

Rezultati : U našem izvještaju komparirali smo MRI rezultate sa kliničkim stagingom (ginekološki pregled ,UZ,ponekad TVUZ ,CT i operativnim nalazom),i dobili senzitivnost metode 89 %, a specifičnost 76 %.

Zaključak: Kao što je poznato iz literature većina autora smatra da je MRI danas metoda izbora za staging malignoma zdjelice,sa izuzetkom za staging ovarijalnih malignoma gdje je CT bolja metoda.

Ključne riječi: ženska zdjelica, oboljenje, malignomi, uterus, ovarij, MRI

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