Value of MRI in Differentiation of High T1 Weighted Image Signal Lesions of the Ovary in Patients with Pelvic Pain

NESREEN MOHEY, M.D.; TAMIR A. HASSAN, M.D. and HAITHAM A. DAWOOD, M.D.
The Department of Radiology, Faculty of Medicine, Zagazig University

Abstract

Aim of the Work: To evaluate the value of MRI in differentiation of high T1 weighted image signal lesions of the ovary in patients with pelvic pain.

Material and Methods: Sixty non pregnant female patients aged 20-48 years (mean 28 years) presented with gynecological pelvic pain with indeterminate US findings of ovarian lesion. MRI pelvis was done for the 60 patients, and revealed 29 patients with high T1WI signal ovarian lesion/lesions and were included in the study. Data from both MRI and US were obtained, and the definite diagnosis was established by histopathological examination (HPE) of the laparoscopically excised ovarian lesions.

Results: Final diagnosis of the 29 patients on the base of HPE of the laparoscopically excised ovarian lesions showing high T 1 WI signal was hemorrhagic ovarian cyst found in 17 patients (58.6%), ovarian endometrioma found in 5 patients (17.2%) and teratodermoid found in 7 patients (24.1 %). US was conclusive in 16 patients (55.2%) while MRI was conclusive in 28 patients (96.6%).

Conclusion: MRI is valuable tool in differentiation of high T 1 WI signal lesions of the ovary in patients with pelvic pain. The use of fat suppressed sequences helps to differentiate hemorrhagic lesions from fat containing lesions.

Key Words: MRI pelvis – Ovarian lesions – Endometrioma – Teratodermoid.

Introduction

OVARIAN masses present a special diagnostic challenge when imaging findings cannot be categorized into benign or malignant pathology. Ultrasonography (US), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) are currently used to evaluate ovarian tumors. US is the first-line imaging investigation for suspected adnexal masses helping in detection and characterization of ovarian tumors [1]. MRI is well known to provide accurate information about hemorrhage, fat, and collagen [2]. It is able to identify different types of tissue contained in pelvic masses, distinguishing benign from malignant ovarian tumors, with an overall accuracy of 88% to 93% [3]. MRI possesses high contrast resolution, ability to provide good tissue characterization, and multiplanar capabilities so (MRI) is increasingly used to evaluate pelvic pathology [4,5]. This technique has super soft-tissue contrast, particularly of the gynecologic organs, additional benefits include absence of ionizing radiation and exposure to iodinated contrast material [6].

Endometriosis, which is defined as the presence of ectopic endometrial glands and stroma outside the uterus, is a common cause of pelvic pain and infertility, affecting as many as 10% of premenopausal women [7]. Mature cystic teratoma, also known as dermoid cyst, is the most common neoplasm of the ovary. Most cystic teratomas are asymptomatic but 3% may present as torsion and more rarely as dermoid cyst rupture. Patients present with acute pelvic pain, nausea and/or vomiting [8].

Subjects and Methods

The study included 60 non-pregnant female patients aged 20-48 years (mean 28 years) seen form May 2012 till October 2013. All patients underwent US examination that revealed indeterminate ovarian lesions. MRI pelvis was done for the 60 selected patients and 29 patients show high T 1 WI signal ovarian lesions and were included in the study to be further analyzed. This study was approved by medical ethics committee and informed consent was given by all patients.

Ultrasound:

Gray-scale US of the entire abdomen and pelvis was performed in all patients by an expert radiologist with 8 years experience in pelvi-abdominal US using a (GE, LOGIQ P6, GE medical system, USA) with multifrequency 3.5MHz convex-array transducer for the transabdominal pelvic examina-
tion and an endovaginal 7.5MHz transducer for the endovaginal pelvic ultrasound examination. For a complete transabdominal pelvic sonogram, the patient was asked to have an adequately distended bladder to act as acoustic window for the pelvic organs and to displace the small bowel from the field of view. For a transvaginal sonogram, the patient was asked to empty her bladder.

During the sonographic examination, the ovaries were evaluated for the size; by measuring the ovary in 3 dimensions (width, length, and depth). Any ovarian abnormalities if present were documented. The adnexal region was examined for any cystic or solid lesions with reporting of its sonographic criteria.

**Inclusion criteria by US according to [9] criteria:**
1- Cyst with reticular areas of internal echoes with no internal flow.
2- Cyst with homogenous low level internal echoes with no internal flow and no solid component.
3- Cyst with focal or diffuse hyperechoic component, area of acoustic shadowing, no internal flow.

According to this US criteria we selected 60 patients to be further analyzed by MRI.

**Magnetic resonance imaging:**

Sixty patients were examined using a 1.5 T scanner (Signa HD 1.5 T machine; GE Medical Systems, USA) using a phased array body coil.

According to MRI findings we included 29 patients with high T1 signal lesion(s) of the ovary to be further characterized and differentiated.

MRI of the pelvis consisted of the many sequences, all summarized in (Table 1). Post contrast axial, coronal and sagittal T1 weighted images with fat saturation were obtained after giving the patient a dose of 0.1 mmol/kg of Gadolinium that was injected automatically at a rate of 2ml/s.

Data from both US and MRI were obtained, and reviewed by three independent radiologists. During interpretation of the images, any disagreements were discussed until a consensus was reached. All images were reviewed on the PACS (GE health care centricity PACS) on dedicated workstation and the imaging findings was correlated with laparoscopic findings.

**Results**

This study included 29 selected patients all share the presence of high T1 signal lesion of the ovary. Final diagnosis of the 29 patients on the base of HPE of the laparoscopically excised ovarian lesions showing high T1WI signal was hemorrhagic ovarian cyst found in 17 patients (58.6%), ovarian endometrioma found in 5 patients (17.2%), teratodermoid found in 7 patients (24.1%).

US was conclusive in (58.8%) of the hemorrhagic ovarian cysts compared to MRI that detected all the cases (Fig. 1). US was conclusive in 2 of the 5 cases with ovarian endometrioma (40%) while MRI detected the 5 cases (Figs. 2,3) and missed malignant transformation in one patient that was revealed by histopathological examination after laparoscopic removal of the cyst for relief of pelvic pain. US was conclusive in 4 of the 7 cases with teratodermoid ovary (57.1%) compared to MRI that detected all the cases (Figs. 4,5). Thus US was conclusive in 16 patients (55.2%) while MRI was conclusive in 28 patients (96.6%) of the study group (Table 2).

MRI Fat suppressed sequences was able to differentiate high T1 signal lesions (short T1 signal lesions) as fat containing lesion (teratodermoid) found in 7 cases were suppressed while hemorrhagic lesions (endometrioma and hemorrhagic cyst) found in 22 patient, maintained the high signal. MRI was superior in detecting T2 dark spot sign (shading), found in 3 out of the 5 patients with endometrioma (Table 3).

### Table (1): MRI parameters for female pelvic examination

<table>
<thead>
<tr>
<th>Plane and pulse sequence</th>
<th>FOV (mm)</th>
<th>Thickness (mm)</th>
<th>Spacing (mm)</th>
<th>Matrix</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal T2 FRFSE</td>
<td>24</td>
<td>4.0</td>
<td>1.0</td>
<td>288x224</td>
<td>3200</td>
<td>108</td>
</tr>
<tr>
<td>Axial T2 FEFSE FS</td>
<td>28</td>
<td>4.0</td>
<td>1.0</td>
<td>320x224</td>
<td>4016</td>
<td>106</td>
</tr>
<tr>
<td>Sagittal T2 FRFSE</td>
<td>24</td>
<td>4.0</td>
<td>1.0</td>
<td>288x224</td>
<td>2800</td>
<td>101</td>
</tr>
<tr>
<td>Axial STIR</td>
<td>28</td>
<td>4.0</td>
<td>1.0</td>
<td>320x256</td>
<td>4366</td>
<td>50</td>
</tr>
<tr>
<td>Coronal STIR</td>
<td>24</td>
<td>4.0</td>
<td>1.0</td>
<td>320x256</td>
<td>6150</td>
<td>46</td>
</tr>
<tr>
<td>Axial T1 FSE</td>
<td>28</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>550</td>
<td>11</td>
</tr>
<tr>
<td>Coronal T1 FSE</td>
<td>24</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>Sagittal T1 FSE</td>
<td>24</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>716</td>
<td>13</td>
</tr>
<tr>
<td>Axial T1 SE FS</td>
<td>28</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>780</td>
<td>10</td>
</tr>
<tr>
<td>Axial T1 post FS</td>
<td>28</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>750</td>
<td>11</td>
</tr>
<tr>
<td>Sagittal T1 post FS</td>
<td>30</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>650</td>
<td>13</td>
</tr>
<tr>
<td>Coronal T1 post FS</td>
<td>30</td>
<td>4.0</td>
<td>1.0</td>
<td>256x160</td>
<td>700</td>
<td>15</td>
</tr>
</tbody>
</table>
Fig. (1): Thirty-one years old female patient with hemorrhagic left ovarian cyst (A) axial T1WI (B) axial T2WI, show well defined high signal left ovarian cyst. (C) coronal T1 fat suppression post contrast shows that cyst maintain the high signal.

Fig. (2): Thirty-three years old female patient with bilateral multiple endometriotic cysts (A) Coronal T1WI (B,C) Coronal T2WI, show bilateral multilocular high signal ovarian cysts with two bright cysts showing fluid level (arrow). (D) Coronal T1 fat suppression post contrast shows that cysts maintain the high signal. (E) Axial T2WI show the fluid level within the cyst (arrow).
Fig. (3): Thirty-eight years old female patient with left endometriotic cysts (A) Axial T1WI (B) Axial (C) Coronal T2WI, show left ovarian multilocular high signal ovarian cyst with, arrow points to associated simple cyst. (D) Axial T1 fat suppression post contrast shows that cysts maintain the high signal; arrow is the associated simple cyst.

Fig. (4): Twenty-seven years old female patient with right ovarian teratodermoid (A) Grey scale US reveals hyperechoic right ovarian lesion (B) Coronal (C) Axial T2WI, show right ovarian high signal lesion. (D) Axial T1 show peripheral high signal and central low signal of the cyst (mixed contents) (E) Axial T1 fat suppression post contrast shows suppression of the signal of the lesion proving fat content.
Fig. (5): Twenty-seven years old female patient with bilateral large teratodermoid ovarian cysts (A) Coronal T2WI (B) Coronal T1WI, show bilateral multiple multilocular ovarian high signal cystic lesions. (D) Coronal T1 fat suppression post contrast shows suppression of the signal of the lesions proving fat content.

Table (2): Final diagnosis of the 29 patients showing high T1WI signal in relation to the modality.

<table>
<thead>
<tr>
<th>Final diagnosis</th>
<th>Conclusive US (number)</th>
<th>Inconclusive US, diagnosed by MRI</th>
<th>Laparoscopic diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhagic ovarian cyst (17, 58.6%)</td>
<td>10 (58.8%)</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Ovarian endometrioma (5, 17.2%)</td>
<td>2 (40%)</td>
<td>4* (80%)</td>
<td>5</td>
</tr>
<tr>
<td>Teratodermoid (7, 24.1%)</td>
<td>4 (57.1%)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total (29)</td>
<td>16 (55.2%)</td>
<td>28 (96.6%)</td>
<td>29</td>
</tr>
</tbody>
</table>

* One case revealed by pathology to be endometrioma with malignant transformatio.

Table (3): MRI Criteria for differentiating high T1 signal ovarian lesion(s).

<table>
<thead>
<tr>
<th>Ovarian lesions</th>
<th>T1 signal</th>
<th>T2WI</th>
<th>T1FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhagic cyst (17)</td>
<td>High</td>
<td>Intermediate to High</td>
<td>High</td>
</tr>
<tr>
<td>Ovarian endometrioma (5):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main bulk</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Shading (T2 dark spot) (3)</td>
<td>Intermediate</td>
<td>Low</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Teratodermoid (7):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main bulk</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Calcifications in (2)</td>
<td>Signal void</td>
<td>Signal void</td>
<td>Signal void</td>
</tr>
</tbody>
</table>

**Discussion**

When an adnexal mass is observed on US examination, MRI can be usefully employed to confirm or refute the benign nature of the lesion because the property of tissue characterization. MRI is an effective second confirmatory test also helpful for problem solving since MRI criteria for ovarian malignancy are clearly established [18].

The study included 60 non-pregnant female patients aged 20-48 years (mean 28 years). Selected patients presented with gynecological pelvic pain or with other symptoms like vaginal bleeding, infertility or dysmenorrhea, all underwent US examination that revealed indeterminate ovarian lesions. MRI pelvis was done for the 60 patients and 29 patients show high T1WI signal ovarian lesions. Final diagnosis of the 29 patients with high T1WI signal was hemorrhagic ovarian cyst found in 17 patients (58.6%), ovarian endometrioma found in 5 patients (17.2%), teratodermoid found in 7 patients (24.1%).

In our study, MR was requested, often because US was inconclusive. MRI revealed 29 patients with high T1 signal lesion of the ovary. They were categorized by MRI into 7 fat containing cystic
lesions and 22 blood containing cystic lesions in agreement with [10] who mentioned that MRI is an important tool in characterization and final diagnosis of pelvic abnormalities that remain indeterminate following ultrasound examination [10]. According to the recommendation of Seigleman and Oliver [7], a T1-weighted fat-suppressed sequence was included in the MRI protocol for two reasons: First, the loss of signal intensity within a T1-hyperintense adnexal mass at fat-suppressed imaging facilitates characterization of fat containing mass as a mature cystic teratoma or dermoid cyst; second saturation of the high signal intensity of fat improves the dynamic range of T1-weighted images by enhancing the differences among non-fat-containing T1-hyperintense structures, thereby enabling more sensitive detection of small endometriomas.

In the present study, hemorrhagic ovarian cysts were found in 17 patients (58.6%); 10 of them (58.8%) demonstrated the typical findings of a hemorrhagic cyst at US according to [9,11] whom stated that the sonographic appearance of hemorrhagic ovarian cyst is variable, depending on the age of the blood, and most show through transmission. Internal echoes as well as internal strands are often seen and are related to fibrin. Unlike septations, strands are numerous, thin, weak reflectors and do not traverse the entire cyst. An internal clot may mimic a solid component, but clots are avascular and have concave borders or angularity due to clot retraction. Regarding the other 10 cases, where the US was inconclusive, 6 of them appeared as hyperechoic ovarian apparently solid mass lesion that needed further characterization. In the other 4 cases, gray scale as well as Color Doppler ultrasound revealed an enlarged cystic mass lesion with no evidence of normal ovarian tissue or flow so ovarian torsion could not be excluded according to [12], who stated that hemorrhagic ovarian cysts are called ‘the great imitator’ owing to their multiple appearances depending on the age of the blood, so further assessment was recommended.

All the cysts showed high signal intensity at T1, maintain high signal at T1 fat suppression and showed wall enhancement which exclude the possibility of torsion, in agreement with Hubert and Bergin [13] whom stated that hemorrhagic ovarian cysts tend to be of relatively high signal intensity on T1W images and of intermediate-to-high signal intensity on T2W images and frequently reveal a fluid-fluid level, and that hemorrhagic cysts should remain of relatively high signal on T1W images with fat suppression, which helps to differentiate them from dermoid cysts in most situations. They also tend to have thicker walls than do simple cysts and may exhibit wall enhancement on post contrast images.

Our study included 5 cases with ovarian endometrioma (17.2%). US was conclusive in 2 cases (40%) where it typical appearance of the endometriotic cyst similar to Kuligowska et al., [14] who found that the typical sonographic appearance of ovarian endometriomas consists of cystic masses that have diffuse low level homogeneous echoes. The contents of the cyst, however, may vary in appearance because of the age of the hemorrhage. In the other 3 cases, US findings were equivocal and further evaluation for the 5 cases by MRI was recommended.

MRI was able to detect the high signal cystic lesion at T1 and T2 with lack of enhancement and was able to detect T2 dark spot sign (shading in 3 cases. One case show malignant transformation when laproscopically removed and sent for histopathological examination in agreement with [15] whom mentioned that the classic endometrioma shows shading, defined as a range of low-signal intensities on T2-weighted images and a corresponding high signal on T1-weighted images. This shading reflects the chronic nature of the endometrioma resulting from repeated episodes of hemorrhage accumulating over months and years with extremely high concentrations of iron, protein, and intracellular methemoglobin.

In our study, US was conclusive in 4 of the 7 cases with ovarian terodermoid (57.1%), according to the criteria found by Outwater et al., [16] whom mentioned that cystic teratomas may appear cystic with hyperechoic areas or hyperechoic densities on ultrasound with loss of through transmission. In the 3 cases in which US was inconclusive, the lesions were complex appearing attaining a large size and an associated ovarian cyst on the same side was also seen, so it was confusing and interpreted as complex adnexal mass for further characterization by MRI. On MRI, all the 7 cases showed high signal at T1 and T2 with signal void calcifications in 2 cysts. All the cysts displayed low signal at T1 fat suppression in agreement with [16] whom mentioned that terodermoid show high signal intensity on T1-weighted images due to the sebaceous component, which is characteristic of dermoid cyst. Fat suppression differentiated fat from other hemorrhagic lesions with no post contrast enhancement.

In our study US was conclusive in 16 patients (55.2%) out of the 29 patients while MRI was
conclusive in 28 patients (96.6%) of the study group population which is near to the results of [17] and in agreement with [3] whom mentioned that MRI is able to identify different types of tissue contained in pelvic masses, distinguishing benign from malignant ovarian tumors, with an overall accuracy of 88% to 93% [3].

**Conclusion:**

MRI is valuable tool in differentiation of high T1 WI signal lesions of the ovary in patients with pelvic pain. The use of fat suppressed sequences helps to differentiate hemorrhagic lesions form fat containing lesions.

**References**