Comparison of 3D and 2D FSE T2-weighted MR imaging in the diagnosis of pelvic endometriosis: preliminary results

Poster No.: C-2243
Congress: ECR 2011
Type: Scientific Exhibit
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Keywords: Genital / Reproductive system female, MR, Computer Applications-3D, Technical aspects, Inflammation
DOI: 10.1594/ecr2011/C-2243

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Purpose

Pelvic endometriosis is a frequent gynecologic disorder affecting 10-15% of women in reproductive years. MRI has been demonstrated to be the best imaging technique to assess the various locations of deep infiltrating endometriosis (DIE). Conventional MRI protocol for the diagnosis of pelvic endometriosis includes multiplanar 2D Fast Spin Echo (FSE) T2-weighted MR images in addition to T1 weighted MR images with and without fat-suppressed technique (1). With this protocol, various studies have demonstrated that MRI is relevant to predict the extension of pelvic endometriosis with a variable accuracy ranging from 71 to 90.8% (2-7). Recently, a new technique (3D fast spin-echo (FSE) CUBE) has been introduced to produce high-resolution volumetric image datasets (8). Volumetric imaging offers an opportunity to reduce the imaging time by allowing multiplanar reformations (MPRs). Previous studies have underlined the relevance of 3D T2-weighted MR imaging in bone, abdominal diseases, and prostate (9-11). Two recent reports have evaluated the contribution of such a 3D technique in comparison to 2D FSE T2-weighted MR imaging in the investigation of female pelvis (12,13). The aim of this study was to compare the overall image quality and diagnostic accuracy of 3D and 2D T2-weighted MR sequences for the evaluation of pelvic endometriosis.

Methods and Materials

Between February 2010 and May 2010, 110 consecutive patients from two different radiological centers (median age: 34 years; range 24-46 years), referred for pelvic MR imaging for a clinical suspicion of endometriosis, were prospectively enrolled (IRB and written informed consent obtained).

MRI technique MR images were acquired on 1.5 Tesla system. In both radiological centers, a conventional protocol including sagittal, axial, coronal oblique FSE T2-weighted images and 3D gradient echo T1 images ± fat suppression was used. Three-dimensional imaging using a coronal single slab 3D TSE T2w CUBE was systematically added.

MRI analysis Images were analyzed blindly by two radiologists with different degrees of experience in female MR imaging (reader 1, highly experienced in gynecologic imaging (>20 years) and reader 2, junior radiologist. Each reader was asked to determine the presence or absence of pelvic endometriosis. First, they reviewed 3D conventional MR images. Second, the two readers reviewed 2D FSE T2 MR images at least 3 weeks in order to minimize recall bias.
Overall image quality evaluation Overall image quality was evaluated with a subjective scale (semi-quantitative) for motion artifacts (e.g., respiratory, intestine) and image quality (i.e.; image quality of the uterus, ovaries, vagina, bladder, intestine) (Fig.1). A standardized scale of 1-3 was used for each variable. The presence of motion artifacts as scored 1, 2, or 3, representing absent, moderate or severe artifacts. The image quality was scored 1, 2, or 3, representing poor, moderate and good evaluation. For all patients and sequences, motion artifacts and image quality scores were calculated. Intra- and interobserver agreement was also calculated.

MR imaging criteria of diagnosis Pelvic endometriosis was diagnosed in the presence of endometrial cysts or DIE locations on T2-w MR images. The diagnosis was performed using a five-point scale to assign a confidence level for evaluation of the absence or presence of each potential location of pelvic endometriosis (ovary, uterosacral ligament, rectosigmoid colon, vagina, and bladder): 1, definitely absent; 2, probably absent; 3, indeterminate; 4, probably present; 5, definitely present. Different locations of endometriosis were performed in accordance with previously described criteria (2,14,16).

Surgical and histological findings All locations of endometriosis were recorded in the surgical reports. Histological criteria used to diagnose pelvic endometriosis were in accordance with previously published reports (2,17,18).

Statistical analysis Descriptive analysis was performed using the Chi-square test for categorical or nominal variables. Confidence level ratings were also used to calculate sensitivity, specificity, PPV, NPV, accuracy and positive and negative likelihood ratios (including 95% CI) of MR images for each sequence in the diagnosis of specific locations of endometriosis. Ratings of 1 to 2 indicated absence and ratings of 4 to 5 indicated a presence of each location of DIE. Ratings of around 3 were considered to indicate an incorrect diagnosis irrespective to the reference standard assessment for each specific pelvic location. Intra- and interobserver agreement between the two readers in the evaluation of overall image quality and for the diagnosis of the different pelvic locations using different MR sequences were quantified by using weighted "statistics". A McNemar test was performed to compare the results of readings of 3D MRI versus results of readings of 2D MRI.

Results

Surgical and pathologic findings Out of 110 patients, 23 underwent surgery. All patients except 3 (87%) had histologically proven pelvic endometriosis. Ovarian endometriosis and DIE was present in 11 (47.8%) and 18 (78.2%) out of 23 patients, respectively. DIE of uterosacral ligaments, vagina, rectosigmoid colon, and bladder
was detected in 17 (73.9%), 5 (21.7%), 13 (56.5%) and 1(4.3%) out of 23 patients, respectively. Complete cul-de-sac obliteration was noted in 10 (30.3%) out of 23 patients.

**Overall imaging quality evaluation** Overall imaging quality evaluation was performed on all 110 MRI examinations. Comparison of motion artifacts and image quality obtained with 3D CUBE and 2D FSE T2-weighted MR sequences is given by table 2, for each reader. Both readers found that 3D CUBE yielded a significantly lower image quality in comparison to 2D FSE T2-weighted image (p<0.0001). The mean acquisition time of multiplanar sagittal, axial and coronal 2D FSE T2-weighted images was 11 minutes 20 seconds. The mean acquisition time for 3D CUBE was 5 minutes 50 seconds. Acquisition time for 3D CUBE was significantly lower than for 2D FSE T2-weighted sequences (p<0.01).

**MRI findings**

Reader 1

3D MR analysis: MRI yielded diagnoses of ovarian endometriosis and DIE in respectively 8 (35%) and 20 (87%) out of 23 patients. MRI yielded diagnoses of torus, uterosacral ligament, vaginal, rectosigmoid, and bladder endometriosis in 14/16 (87.5%), 16/17 (94.1%), 4/5 (80%), 10/13 (76.9%) and 1/1 (100%) patients, respectively. Cul-de-sac obliteration was noted in 7(70%) out of 10 patients.

2D MR analysis: MRI yielded diagnoses of ovarian and DIE in respectively 8 (35%) and 20 (87%) out of 23 patients. MRI yielded a diagnoses of torus, uterosacral ligament, vaginal, rectosigmoid, and bladder endometriosis in 13/16 (77.2%), 15/17 (88.2%), 3/5 (60%), 11/13 (84.6%), and 1/1 (100%) patients, respectively. Cul-de-sac obliteration was noted in 7 (70%) out of 10 patients.

Reader 2

3D MR analysis: MRI yielded diagnoses of ovarian and DIE in respectively 14 (61%) and 21 (91%) out of 23 patients. MRI yielded a diagnoses of torus, uterosacral ligament, vaginal, rectosigmoid, and bladder endometriosis in 14/16 (87.5%), 17/17 (100%), 3/5 (60%), 10/13 (76.9%), and 1/1 (100%) patients, respectively. Cul-de-sac obliteration was noted in 7(70%) out of 10 patients.

2D MR analysis: MRI yielded diagnoses of ovarian and DIE in respectively 15 (65%) and 19 (83%) out of 23 patients. MRI yielded diagnoses of torus, uterosacral ligament, vaginal, rectosigmoid, and bladder endometriosis in 13/16 (77.2%), 15/17 (88.2%), 3/5 (60%), 11/13 (84.6%), and 1/1 (100%) patients, respectively. Cul-de-sac obliteration was noted in 7 (70%) out of 10 patients.
Comparison of 3D and 2D T2-w MRI for the diagnosis of specific locations of pelvic endometriosis

A poor interobserver agreement for the assessment of DIE was found to assess uterosacral ligament endometriosis. For all locations of endometriosis, a high intraobserver agreement was observed for reader 1 while reader 2 had a low or poor intraobserver agreement for uterosacral ligament and rectosigmoid endometriosis as well as Douglas pouch obliteration.

Conclusion

The present study demonstrates that despite a lower overall imaging quality, 3D CUBE offers similar accuracy to diagnose DIE compared to 2D FSE T2-weighted MRI.

MRI evaluation of pelvic endometriosis is routinely performed with multiplanar sagittal, axial and coronal 2D FSE T2-weighted sequences. These sequences are significantly longer to acquire, compared to 3D CUBE, and on average twice as long. This gain in acquisition time represents a major advantage of 3D CUBE.

Our study is the first focusing on the contribution of 3D T2-weighted MR imaging to assess various locations of pelvic endometriosis (ovarian and deep).

A low accuracy in depicting endometriomas, whatever the level of expertise of each reader, was found. This could be partly explained by the absence of use of T1-weighted MR sequences, which are the gold standard MRI sequence to diagnose endometriomas.

The accuracy of 3D CUBE to diagnose specific DIE locations was similar to that observed using 2D FSE T2-weighted MRI (i.e., uterosacral ligaments, vagina, rectosigmoid and bladder) (2,4,6,25). In accordance with Saba et al, we found that interobserver agreement was suboptimal for identification of endometriosis located in the uterosacral ligament (7).

3D CUBE was as accurate as 2D FSE T2- weighted MRI for the diagnosis of rectosigmoid endometriosis (2-5,7,24,27).

3D CUBE allowed a better detection of vaginal endometriosis for the most experienced reader.

Bladder involvement was correctly detected with both techniques.

Several limitations of the study must be underlined. First, our readers were aware that patients were suspected of having pelvic endometriosis. Second, only the most frequent endometriotic locations, including ovary, uterosacral ligament, vagina and rectosigmoid were studied. Third, patients who had previous surgery for DIE were not excluded from the analysis. Fourth, during the review sessions, our two readers rated all 2D FSE T2-
weighted MR images together for overall image quality analysis. Finally, the number of operated patients was small and may preclude any definitive conclusion.

In conclusion, 3D CUBE in combination with an MPR technique yields accuracy that is not significantly different from the accuracy of 2D FSE T2-weighted MR imaging in the diagnosis of ovarian endometriosis and DIE locations. In addition, 3D CUBE allows significant time saving but is associated with a lower overall image quality.

References


**Personal Information**

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