Human Reproduction Vol.22, No.5 pp. 1457–1463, 2007 doi:10.1093/humrep/dem008
Advance Access publication February 15, 2007

Accuracy of magnetic resonance imaging and rectal endoscopic sonography for the prediction of location of deep pelvic endometriosis

Marc Bazot[1,5], Carole Bornier[1], Gil Dubernard[2], Gilles Roseau[4], Annie Cortez[3] and Emile Daraï[2]

[1]Services de Radiologie, [2]Gynécologie-Obstétrique, [3]Anatomo-pathologie, Hôpital Tenon, Paris, APHP, France and [4]Centre chirurgical Trocadéro, département d'endoscopie digestive, Paris, France

[5]To whom correspondence should be addressed at: Service de Radiologie, Hôpital Tenon, 4 rue de la Chine, 75020 Paris, APHP, France. Tel: +33 1 56 01 64 53; Fax: +33 1 56 01 64 02; E-mail: marc.bazot@tnn.aphp.fr

BACKGROUND: We compared the accuracy of magnetic resonance imaging (MRI) and rectal endoscopic sonography (RES) for the diagnosis of deep pelvic endometriosis (DPE), with respect to surgical and histological findings. METHODS: Longitudinal study of 88 consecutive patients referred for surgical management of DPE, who underwent both MRI and RES pre operatively. The diagnostic criteria were identical for MRI and RES and were based on visualization of hypointense/hypoechoic areas in specific locations. DPE was diagnosed when at least one site was involved. We calculated the sensitivity, specificity, predictive values, accuracy and 95% confidence interval of MRI and RES for DPE. RESULTS: DPE and endometriomas were present in 97.7 and 39.7% of women, respectively. The sensitivity, specificity and positive and negative predictive values of MRI and RES, respectively, were 84.8 and 45.6%, 88.8 and 40%, 98.5 and 87.8% and 40 and 8.5% for uterosacral endometriosis; 77.7 and 7.4%, 70% and 100, 85.3 and 100% and 89.7 and 70.9% for vaginal endometriosis and 88.3 and 90%, 92.8 and 89.3%, 96.4 and 94.7% and 78.8 and 80.6% for colorectal endometriosis. CONCLUSIONS: MRI is more accurate than RES for the diagnosis of uterosacral and vaginal endometriosis, whereas the two methods are similarly accurate for colorectal endometriosis.

Key words: endometriosis/magnetic resonance imaging/rectal endoscopic sonography/ultrasonography/uterosacral ligaments

Introduction

Deep pelvic endometriosis (DPE) is defined as the presence of endometrial implants, fibrosis and muscular hyperplasia below the peritoneum. DPE involves, in descending order of frequency, the uterosacral ligaments, the rectosigmoid colon, the vagina and the bladder (Jenkins *et al.*, 1986). The exact incidence of DPE is unknown, but DPE is diagnosed in about one in five women with pelvic endometriosis.

Despite a strong correlation between symptoms and DPE (Fauconnier *et al.*, 2002; Chapron *et al.*, 2003a), physical examination, even during menstruation, has a limited capacity to diagnose and quantify DPE (Koninckx and Martin, 1994; Chapron *et al.*, 2002a). Transrectal or rectal endoscopic sonography (RES), transvaginal sonography (TVS) and magnetic resonance imaging (MRI) have been all recommended to diagnose and locate DPE (Chapron *et al.*, 1998; Kinkel *et al.*, 1999; Roseau *et al.*, 2000; Bazot *et al.*, 2001, 2003, 2004a; Bazot and Darai, 2005).

Transrectal sonography (TRS) and RES have been recommended for the diagnosis of uterosacral, rectovaginal septal and intestinal endometriosis (Ohba *et al.*, 1996; Chapron *et al.*, 1998, 2004 Fedele *et al.*, 1998; Roseau *et al.*, 2000; Delpy *et al.*, 2005). RES with a high-frequency probe is more widely used than TRS because it provides an overview of the rectosigmoid colon (Chapron *et al.*, 1998, 2004; Roseau *et al.*, 2000; Delpy *et al.*, 2005). However, Delpy *et al.* (2005) reported that RES was poorly accurate for evaluating the various locations of DPE, with the exception of intestinal endometriosis.

Several reports have suggested that MRI is the best non-invasive method for evaluating the different locations of pelvic endometriosis (Arrive *et al.*, 1989; Togashi *et al.*, 1991; Siegelman *et al.*, 1994; Takahashi *et al.*, 1994; Fedele *et al.*, 1997; Outwater *et al.*, 1998; Kinkel *et al.*, 1999; Balleyguier *et al.*, 2002; Bazot *et al.*, 2004b). Recently, we found that MRI permitted accurate diagnosis of both anterior and

posterior DPE (Bazot *et al.*, 2004b). Chapron *et al.* (2004) concluded that RES was more reliable than MRI for detecting intestinal endometriosis.

The aims of this study were to evaluate the accuracy of MRI and RES for the prediction of location of DPE, in a large series of women with surgical and histological documentation.

Materials and methods

This longitudinal study involved 88 consecutive women referred for surgical management of DPE between April 2000 and March 2005. All the women underwent both MRI and RES before surgery. The women ranged in age from 20 to 51 years (mean 32.1 years). Twenty-nine patients (32.9%) had a history of pelvic surgery. The principal clinical disorders were dysmenorrhoea ($n = 70$), dyspareunia ($n = 55$), dyschezia ($n = 28$), urinary disorders ($n = 3$) and infertility ($n = 19$).

All MRI and RES examinations were performed independently by different physicians and were interpreted in real time.

MRI technique and analysis

Patients fasted for at least 3 h before MRI and received an i.v. antispasmodic drug at the outset of the examination to decrease bowel peristalsis. MR images were acquired on a 1.5 T device. The protocol always included sagittal and axial fast spin-echo T2-weighted images and gradient echo T1 images with and without fat suppression, before and after injection of gadolinium. All sequences were acquired with anterior and posterior saturation bands placed anteriorly and posteriorly to eliminate the high signal of subcutaneous fat. Additional sequences could be performed, especially for suspected rectal involvement. The performance of the different sequences was not compared.

The MR images were analysed in real time by different radiologists. Interobserver variability was not calculated. The radiologists were asked to determine whether DPE was present or absent. DPE was defined as the presence of implants of endometrial tissue in the subperitoneal space and in intraperitoneal structures (mainly the intestinal tract, and especially the sigmoid colon). Additional disorders such as ovarian endometriosis, the topography of the uterus (anteflexed or retroflexed) and associated uterine adenomyosis were diagnosed using published criteria (Nishimura *et al.*, 1987; Togashi *et al.*, 1988, 1991; Bazot *et al.*, 2001).

The diagnosis of DPE was based on the combined presence of signal abnormalities (Bazot *et al.*, 2004b) (e.g. hyperintense foci on T1-weighted and/or fat-suppression T1-weighted MR images, corresponding to haemorrhagic foci or small hyperintense cavities on T2-weighted images, or areas corresponding to fibrosis, with a signal close to that of pelvic muscle on T1- and T2-weighted images, with or without foci or cavities and with or without contrast enhancement after gadolinium injection) and morphological abnormalities. These features were evaluated at each site of posterior or anterior DPE. The abnormalities varied according to the anatomical location, as follows.

Posterior pelvic space

Uterosacral ligaments (USLs): involvement by endometriosis was recorded when the ligament bore a nodule (regular or with stellate margins) or showed fibrotic thickening compared to the contralateral USL, with regular or irregular margins (Figure 1). The unilateral/bilateral nature of the involvement, and involvement of the torus uterinus (arciform abnormality), was noted. When a USL was considered abnormal and was clearly distinguished from adjacent structures, its size was measured in its proximal portion, close to its insertion on the cervix, on the axial or sagittal view.

Vagina: obliteration of the hypointense signal of the posterior vaginal wall on T2-weighted images, with thickening or a mass (containing or not containing foci) behind the posterior wall of the cervix (Figure 2).

Rectovaginal septum: nodule or mass passing through the lower border of the posterior lip of the cervix (under the peritoneum) (Figure 3).

Rectum/sigmoid colon: disappearance of the fat tissue plane lying between the uterus and the rectum/sigmoid colon and its replacement by a tissue mass; disappearance of the hypointense signal of the anterior wall of the rectum/sigmoid colon on T2-weighted images and contrast enhancement on T1-weighted images (Figure 4). Abnormalities forming an obtuse angle with the wall of the rectum/sigmoid colon, the degree of extension and particularly the distance

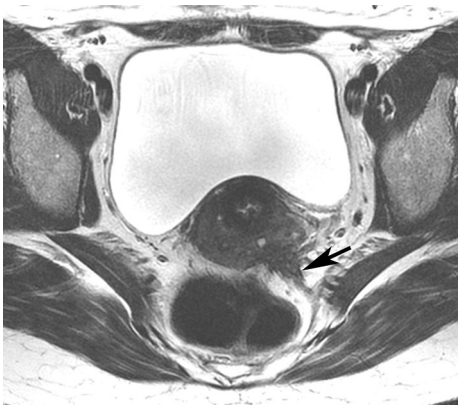

Figure 1. Uterosacral ligament endometriosis: axial T2-weighted magnetic resonance imaging (MRI) passing through the cervix and the posterior vaginal fornix and showing irregular thickening of the left uterosacral ligament (arrow).

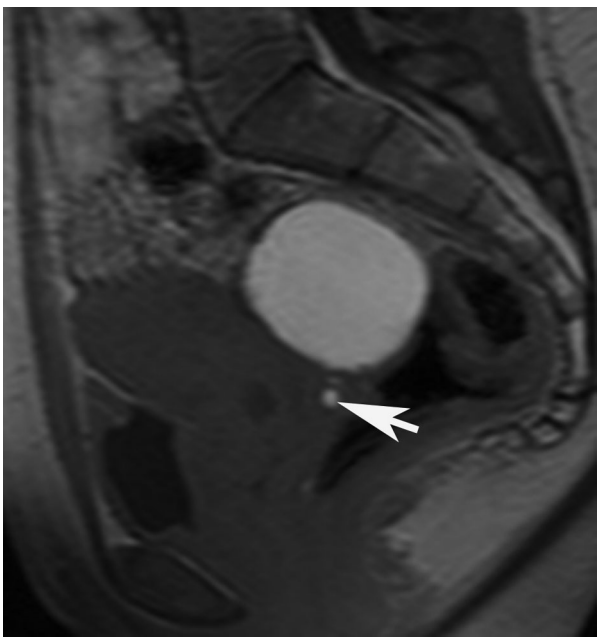

Figure 2. Vaginal endometriosis: sagittal T1-weighted MRI showing hyperintense spots within the posterior vaginal fornix (arrow). Note the presence of the endometrioma in the pouch of Douglas.

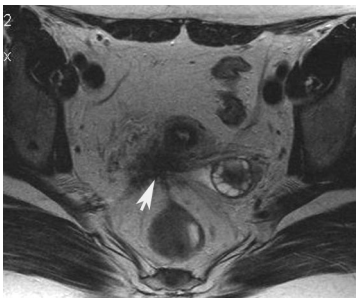

Figure 3. Rectovaginal endometriosis: axial T2-weighted MRI passing through the lower limit of the cervix and showing an irregular hypointense endometriotic lesion of the rectovaginal septum (arrow).

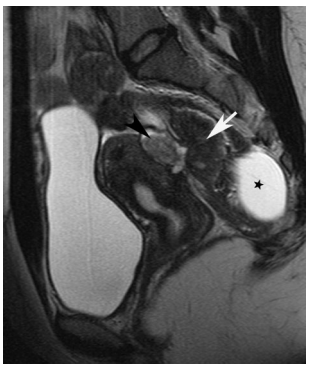

Figure 4. Rectosigmoid colon endometriosis: sagittal T2-weighted MRI showing complete obliteration of the cul-de-sac due to intestinal endometriosis (white arrow) associated with endometrioma (arrowhead). Note the retroperitoneal collection behind the rectosigmoid colon (star).

between the lower limit of the fibrotic mass and the rectal–anal junction were recorded.

Anterior pelvic space

Bladder involvement: nodule or mass usually located at the level of the vesicouterine pouch, forming an obtuse angle with the bladder wall; extension through the bladder wall involving the muscularis layer (obliteration of the hypointense signal of the wall on T2-weighted images), or protruding into the lumen with invasion of the mucosal layer (Figure 5).

Rectal endoscopic sonography

After a simple rectal enema, RES was performed with an Olympus GF UM 20 Echo endoscope (SCOP Medicine Olympus, 94150 Rungis, France) with a diameter of 11.4 mm, operating at 7.5 and 12 MHz. The procedure was performed under general anaesthesia in 40 women (45.5%) and with local or topical anaesthesia in 48 women (54.5%). The transducer was always positioned in the sigmoid and then slowly withdrawn through the sigmoid and rectum. Studies of the bowel wall and adjacent areas were carried out by moving the probe up and down several times before and after instilling water into the intestinal lumen. Involvement of the uterosacral ligaments, the vagina and the rectosigmoid colon was analysed.

DPE was defined by the presence of a hypoechoic nodule or mass, with or without regular contours. The largest diameter of the lesions, their location relative to the anal margins and infiltration of adjacent pelvic organs were assessed. In the rectum and/or sigmoid colon, involvement of the muscularis propria (hypoechoic and thin) was distinguished from the hyperechoic submucosa and mucosa (Figure 6). When possible, an attempt was made to evaluate the depth to which

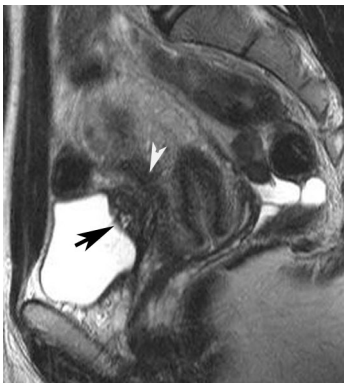

Figure 5. Bladder endometriosis: sagittal T2-weighted MRI showing a fibrotic mass in the dome of the bladder, in front of the vesico-uterine pouch (arrow). Note the associated anterior adenomyosis (arrowhead).

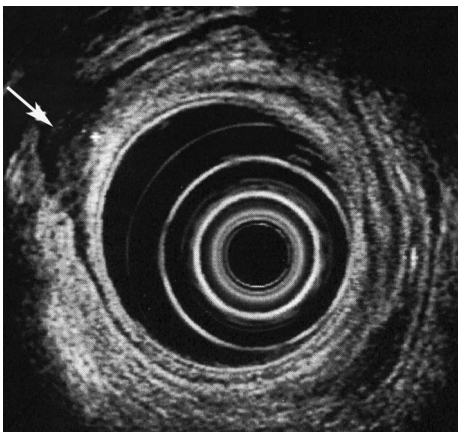

Figure 6. Rectal endoscopic sonography showing involvement of the rectal wall by deep pelvic endometriosis (arrow).

the deep endometriosis penetrated into the rectal wall (muscularis propria, submucosa or mucosa).

Surgical and pathological findings

The histological criteria used for the diagnosis of pelvic endometriosis included the presence of ectopic endometrial tissue (ectopic glands together with stroma) (Clement, 2002).

DPE was diagnosed in the following circumstances: (i) if endometrial tissue (glands and stroma) was found on histological examination of at least one resected subperitoneal lesion (Cornillie *et al.*, 1990); (ii) DPE was directly visualized during laparoscopy or laparotomy but only fibrosis and smooth-muscle cells were found on biopsy, or the lesion was not biopsied (Adamson and Nelson, 1997). In this latter case, subperitoneal endometriosis was diagnosed if another histologically proven site of endometriosis was found. (iii) Complete cul-de-sac obliteration secondary to endometriosis was observed but could not necessarily be surgically cleared. Like Reich *et al.* (1991), we considered that deep retrocervical endometriosis was present below the peritoneum in such cases.

The largest diameter of the lesions was measured by palpation after colorectal resection. Infiltration of the muscularis propria, submucosa or mucosa of the rectosigmoid colon was recorded.

As recommended by Chapron *et al.* (2003), a deep endometriotic location was considered isolated (bladder or USLs or vagina or intestine) when it was not associated with any of the other deep pelvic endometriotic locations.

Statistical analysis

The sensitivity, specificity, positive and negative predictive values, accuracy and 95% confidence interval of MRI and RES were evaluated for each site of endometriotic involvement.

Parametric and non-parametric continuous variables were compared using Student's *t*-test, and categorical variables were compared using the chi-square test, Fisher's exact test, the Mac Nemar test or the *Z*-statistic as appropriate. $P < 0.05$ were considered statistically significant.

Results

Surgical and pathological findings

DPE was found at surgery plus biopsy and at surgery alone in 78/86 (90.7%) and 8/86 (9.3%) cases, respectively. DPE was associated with endometriomas in 35/88 cases (39.8%). Two patients with clinical and surgical signs of uterosacral endometriosis did not meet all the histological criteria for endometriosis and were thus considered disease-free, but one of these two women had a histologically confirmed endometrioma. The distribution of the different sites of DPE is reported in Table I. DPE was posterior and anterior in 86 (97.7%) and 3 (3.4%), respectively, of the 88 women. Both the anterior and posterior compartments were involved in three women (3.4%).

Among women who underwent colorectal resection (61.4%), histological examination confirmed endometriotic involvement of the muscularis propria, submucosa and mucosa in 51 (94.4%), 19 (35.2%) and 2 (3.7%) cases, respectively.

Table I. Surgically and pathologically documented sites of deep pelvic endometriosis

Deep pelvic locations	Surgery	Biopsy	Histology	Isolated
Posterior	86	78	76	83
USLs	81	71	69	18
Vagina	27	18	18	1
Rectovaginal septum	9	9	9	0
Intestines	60	54	51	3
Sigmoid colon	6	5	5	2
Rectosigmoid junction	42	38	35	1
Rectum	12	11	11	0
Anterior: bladder	3	3	3	1

USLs, uterosacral ligaments.

Isolated DPE of the bladder, vagina, intestines and USLs was detected in 1/88 (1.1%), 1/88 (1.1%), 3/88 (3.4%) and 18/88 (20.5%) patients, respectively.

MRI findings

The sensitivity, specificity, positive and negative predictive values and accuracy of MR imaging for the diagnosis of the different locations of pelvic endometriosis are shown in Table II.

MRI yielded a diagnosis of USL endometriosis in 68 patients (77.3%), with 12 and 1 false-negative and false-positive cases, respectively.

MRI yielded a diagnosis of vaginal endometriosis in 30 patients (34%), with six and nine false-negative and false-positive cases, respectively.

MRI yielded a diagnosis of rectovaginal endometriosis in five patients (5.8%), with five and one false-negative and false-positive cases, respectively.

MRI yielded a diagnosis of intestinal endometriosis in 55 patients (62.5%), with seven and two false-negative and false-positive cases, respectively.

MRI yielded a diagnosis of bladder endometriosis in three patients (3.7%). The mean size of endometriotic lesions of the bladder was 28.1 mm (range 25–30 mm).

MRI yielded a diagnosis of ovarian endometriosis in 41 (46.6%) patients, with one and seven false-negative and false-positive cases, respectively.

RES findings

The sensitivity, specificity, positive and negative predictive values and accuracy of RES for the diagnosis of the different locations of pelvic endometriosis are given in Table III.

RES yielded a diagnosis of USL endometriosis in 41 patients (46.6%), with 43 and 5 false-negative and false-positive cases, respectively.

RES yielded a diagnosis of vaginal endometriosis in two patients (2.3%), with 25 false-negative cases and no false-positive case.

RES yielded a diagnosis of rectovaginal endometriosis in six patients (6.8%), with seven and four false-negative and false-positive cases, respectively.

Table II. Pelvic endometriosis: correlation of magnetic resonance imaging results with surgical and pathological findings

	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Accuracy (95% CI)
USLs	84.8% (67/79) (75.3–91.1)	88.8% (8/9) (56.5–98.0)	98.5% (67/68) (92.1–99.7)	40% (12/20) (38.6–78.1)	70% (75/88) (76.4–91.2)
Vagina	77.7% (21/27) (59.2–89.4)	85.3% (52/61) (74.3–92.0)	70% (21/30) (52.1–83.3)	89.7% (52/61) (74.3–92.0)	82.9% (73/88) (73.8–89.4)
RV septum	44.4% (4/9) (18.9–73.3)	98.7% (78/79) (93.2–99.8)	80% (4/5) (37.5–96.4)	93.9% (78/83) (86.6–97.4)	93.2% (82/88) (85.9–96.8)
Intestines	88.3% (53/60) (77.8–99.2)	92.8% (26/28) (77.4–98.0)	96.4% (53/55) (87.7–99.0)	78.8% (26/33) (62.3–89.3)	89.8% (79/88) (81.7–94.5)
Ovary	97.1% (34/35) (81.4–98.4)	86.8% (46/53) (71.8–92.4)	82.9% (34/41) (68.1–91.3)	97.9% (46/47) (83.9–98.7)	90.9% (80/88) (80.2–94.0)

RV septum, rectovaginal septum; PPV, positive predictive value; NPV, negative predictive value; CI, confidence interval.

Table III. Pelvic endometriosis: correlation between rectal endoscopic sonography and surgical and pathological findings

	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Accuracy (95% CI)
USLs	45.6% (36/79) (35.1–56.5)	44.4% (4/9) (18.9–73.3)	87.8% (36/41) (75.5–94.7)	8.5% (4/47) (3.4–19.3)	45.5% (40/88) (35.5–55.8)
Vagina	7.4% (2/27) (2.1–23.4)	100% (61/61) (94.1–100.0)	100% (2/2) (34.2–100.0)	70.9% (61/86) (60.6–79.5)	71.6% (63/88) (61.4–80.0)
RV septum	22.2% (2/9) (6.3–54.7)	94.9% (75/79) (87.7–98.0)	33.3% (2/6) (9.7–70.0)	91.5% (75/82) (83.4–95.8)	87.5% (77/88) (80.0–92.9)
Intestines	90% (54/60) (79.6–95.3)	89.3% (25/28) (72.8–96.3)	94.7% (54/57) (85.6–98.2)	80.6% (25/31) (63.7–90.8)	89.8% (79/88) (81.7–94.5)
Ovary	62.9% (22/35) (47.3–76.6)	92.5% (49/53) (81.4–97.6)	84.6% (22/26) (71.9–96.2)	79% (49/62) (61.1–83.9)	80.7% (71/88) (68.9–86.5)

RES yielded a diagnosis of intestinal endometriosis in 57 patients (64.8%), with six and three false-negative and false-positive cases, respectively.

RES yielded a diagnosis of ovarian endometriosis in 26 patients (29.5%), with 13 and 4 false-negative and false-positive cases, respectively.

Comparison of MRI and RES for the diagnosis of posterior

With histological findings as the reference standard, MRI and RES correctly diagnosed DPE in 84 and 64 women, respectively, and colorectal endometriosis in 53 and 54 women. The Mac Nemar test showed a significant difference in diagnostic accuracy between MRI and RES as regards DPE ($P < 0.05$), but not colorectal endometriosis.

There was one false-positive RES diagnosis of DPE (uterosacral endometriosis). When the results of the two methods were combined, there remained seven false-negative diagnoses, all of uterosacral endometriosis. RES gave 21 false-negative diagnoses, of which 14 (66.7%) were correctly diagnosed by MRI. MRI gave 11 false-negative diagnoses, of which 4 (36.4%) were correctly diagnosed by RES.

Among the 54 cases of resected colorectal endometriosis, MRI and RES correctly diagnosed muscularis propria involvement in 50/51 (98%) and 46/51 cases (90.2%), respectively. RES correctly diagnosed submucosal and mucosa rectal infiltration in 3/19 (15.8%) and 0/2 cases, respectively.

The largest macroscopic diameter of the endometriotic lesions ranged from 5 to 95 mm (mean 33.26 mm). The mean size ($\pm$range) of the colorectal lesions, as assessed by MRI and RES, respectively, was 29.8 mm (range 5–60 mm) and 14.5 mm (range 10–35 mm). Relative to histological measurements, the size of colorectal endometriotic lesions was correctly assessed by MRI ($P < 0.05$) but not by RES.

Discussion

This longitudinal study shows that MRI is more accurate than RES for diagnosing the different sites of DPE, with the exception of intestinal endometriosis, for which MRI and RES had similar accuracy.

Correct evaluation of the location and extent of endometriotic involvement is important, so that patients can be given appropriate information on the potential risks of surgery. Although TVS is the main imaging technique used to evaluate pelvic endometriosis, there are few data on its accuracy for DPE (Bazot *et al.*, 2004a; Bazot and Darai, 2005). Other imaging techniques such as TRS, RES and MRI have also been recommended (Fedele *et al.*, 1997; Chapron *et al.*, 1998; Kinkel *et al.*, 1999; Roseau *et al.*, 2000; Balleyguier *et al.*, 2002; Bazot *et al.*, 2004b; Delpy *et al.*, 2005). Our findings support the results of a previous study showing that MRI is highly accurate for the diagnosis of both anterior and posterior DPE (Bazot *et al.*, 2004b). In contrast, RES cannot explore anterior endometriotic locations. In addition, RES is not suitable for diagnosing endometrial ovarian cysts. Indeed, RES probes, operating from 7.5 to 12 MHz, permit adequate evaluation of proximal organs and anatomic structures. We therefore restricted our comparison of RES and MRI to the diagnosis of endometriosis involving the USLs, rectosigmoid colon, vagina and rectovaginal septum.

This study confirms that the USLs are the main site of DPE. Involvement of this site was isolated in 22% of our patients. Delpy *et al.* (2005) reported that RES had a sensitivity of 42% (8/19 cases) for USL endometriosis, a value similar to that found here. In contrast, Fedele *et al.* (1998) reported that TRS had a sensitivity of 80% (8/10) for USL involvement. This discrepancy may be partly explained by the high prevalence of multiple posterior DPE in our series, possibly contributing to an underestimation of this location. Preoperative diagnosis of USL endometriosis is particularly important for the surgeon, as removal of these lesions is associated with a high risk of bladder dysfunction (Volpi *et al.*, 2004). Nerve-sparing surgery of the inferior hypogastric plexus has been recommended to avoid this complication; it is especially feasible in women with isolated USL endometriosis, whereas more extensive endometriotic lesions are not always compatible with this conservative surgery (Volpi *et al.*, 2004).

Rectosigmoid endometriosis is one of the most severe forms of DPE. Colorectal resection is associated with a high risk of complications, but less extensive surgery can be associated with clinical recurrences requiring additional treatment (Fedele *et al.*, 2004, 2005). Dubernard *et al.* (2006) have shown that colorectal resection is associated with a significant improvement in quality of life. Therefore, accurate preoperative diagnosis of intestinal endometriosis is essential to inform women on the specific risks of surgery (especially

de-novo digestive and urinary symptoms). In the current study, MRI and RES had similar accuracies for intestinal endometriosis with muscularis propria involvement. However, neither MRI nor RES correctly assessed the depth of penetration into the bowel wall. MRI also accurately showed the size of colorectal endometriotic lesions, contrary to RES. Further studies are required to determine the place of RES, alone or combined with MRI, in the pre-operative assessment of intestinal endometriosis, particularly in terms of cost-effectiveness and availability relative to MRI. In this specific setting, RES that require general anaesthesia in several patients may be used only to better define the lesion suspected by MRI.

One-third of our patients had vaginal endometriosis, almost always associated with other sites of DPE. Its diagnosis is particularly important, owing to the need for specific additional procedures and to the complications of surgical excision. Indeed, excision of vaginal endometriosis raises specific surgical issues, such as pelvic infection and rectovaginal fistulae, especially in women with associated rectosigmoid involvement. Concomitant vaginal and intestinal resection is required, carrying a risk of rectovaginal fistulae, which is the main complication of colorectal resection (Darai *et al.*, 2005a). Protective colostomy is required to avoid this complication, imposing the need for a second operation; post-operative adhesions are also frequent, with possible repercussions for subsequent fertility (Darai *et al.*, 2005b). We found that MRI had acceptable accuracy for the diagnosis of vaginal endometriosis, whereas RES failed to identify 25 of the 27 cases. One possible explanation for the low accuracy of RES is its inability to distinguish between rectal and vaginal endometriosis, as the ultrasound energy is absorbed by the first few millimetres of bowel involvement.

Rectovaginal septum involvement was relatively infrequent in this study (10.2%) and was always associated with other sites of DPE. Nisolle and Donnez (1997) suggested that rectovaginal septum endometriosis should be considered as an adenomyotic lesion corresponding to the reminiscence of embryonic residual without connection to pelvic endometriosis. However, our findings support the three-step development of pelvic endometriosis postulated by Koninckx *et al.* (1991, 1994) and recently confirmed by Chapron *et al.* (2002b). MRI and RES both had low sensitivity and high specificity for rectovaginal septum endometriosis, in keeping with previous reports (Bazot *et al.*, 2003, 2004b).

Several limitations of our study must be considered. First, the prevalence of DPE was particularly high, creating a possible source of bias. As a matter of fact, the posterior probability of positive test (100%) was truly similar to pretest probability (98%, i.e. prevalence). Our findings cannot therefore be extrapolated to the general population of women with symptoms of DPE. To evaluate the overall presence of DPE, another study including patients with chronic pelvic pain, not only patients referred for surgical management of DPE, should be performed. Second, we were unable to refine the specific indications of RES, owing to the retrospective nature of our study. Finally, no attempt was made to evaluate the intra- and inter-observer variability of MRI and RES.

In conclusion, this study shows that MRI is more accurate than RES for the diagnosis of DPE and for determining the precise sites of involvement. In contrast, MRI and RES had similar accuracy for the diagnosis of intestinal endometriosis. Further studies are required to determine the precise place of RES in the pre-operative assessment of DPE.

References

Adamson GD and Nelson HP (1997). Surgical treatment of endometriosis. Obstet Gynecol Clin North Am 24,375–409.

Arrive L, Hricak H and Martin MC (1989). Pelvic endometriosis: MR imaging. Radiology 171,687–692.

Balleyguier C, Chapron C, Dubuisson JB, Kinkel K, Fauconnier A, Vieira M, Helenon O and Menu Y (2002). Comparison of magnetic resonance imaging and transvaginal ultrasonography in diagnosing bladder endometriosis. J Am Assoc Gynecol Laparosc 9,15–23.

Bazot M and Darai E (2005). Sonography and MR imaging for the assessment of deep pelvic endometriosis. J Minim Invasive Gynecol 12,178–185.

Bazot M, Cortez A, Darai E, Rouger J, Chopier J, Antoine JM and Uzan S (2001). Ultrasonography compared with magnetic resonance imaging for the diagnosis of adenomyosis: correlation with histopathology. Hum Reprod 16,2427–2433.

Bazot M, Detchev R, Cortez A, Amouyal P, Uzan S and Darai E (2003). Transvaginal sonography and rectal endoscopic sonography for the assessment of pelvic endometriosis: a preliminary study. Human Reprod 18,1686–1692.

Bazot M, Darai E, Hourani R, Thomassin I, Cortez A, Uzan S and Buy JN (2004b). Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. Radiology 232,379–389.

Bazot M, Thomassin I, Hourani R, Cortez A and Darai E (2004a). Diagnostic accuracy of transvaginal sonography for deep pelvic endometriosis. Ultrasound Obstet Gynecol 24,180–185.

Chapron C, Dumontier I, Dousset B, Fritel X, Tardif D, Roseau G, Chaussade S, Couturier D and Dubuisson JB (1998). Results and role of rectal endoscopic ultrasonography for patients with deep pelvic endometriosis. Hum Reprod 13,2266–2270.

Chapron C, Dubuisson JB, Pansini V, Vieira M, Fauconnier A, Barakat H and Dousset B (2002a). Routine clinical examination is not sufficient for diagnosing and locating deeply infiltrating endometriosis. J Am Assoc Gynecol Laparosc 9,115–119.

Chapron C, Liaras E, Fayet P, Hoeffel C, Fauconnier A, Vieira M, Barakat H, Dousset B, Legmann P, Bonnin A, *et al.* (2002b). Magnetic resonance imaging and endometriosis: deeply infiltrating endometriosis does not originate from the rectovaginal septum. Gynecol Obstet Invest 53,204–208.

Chapron C, Dubuisson JB, Chopin N, Foulot H, Jacob S, Vieira M, Barakat H and Fauconnier A (2003). Deep pelvic endometriosis: management and proposal for a "surgical classification". Gynecol Obstet Fertil 31,197–206.

Chapron C, Fauconnier A, Dubuisson JB, Barakat H, Vieira M and Breart G (2003a). Deep infiltrating endometriosis: relation between severity of dysmenorrhoea and extent of disease. Hum Reprod 18,760–766.

Chapron C, Vieira M, Chopin N, Balleyguier C, Barakat H, Dumontier I, Roseau G, Fauconnier A, Foulot H and Dousset B (2004). Accuracy of rectal endoscopic ultrasonography and magnetic resonance imaging in the diagnosis of rectal involvement for patients presenting with deeply infiltrating endometriosis. Ultrasound Obstet Gynecol 24,175–179.

Clement MD (2002). Diseases of the peritoneum (including endometriosis). In RJ Kurman (eds) Blaustein's Pathology of the Female Genital Tract. Springer-Verlag, New York. vol. 1, pp 729–789.

Cornillie FJ, Oosterlynck D, Lauweryns JM and Koninckx PR (1990). Deeply infiltrating pelvic endometriosis: histology and clinical significance. Fertil Steril 53,978–983.

Darai E, Marpeau O, Thomassin I, Dubernard G, Barranger E and Bazot M (2005b). Fertility after laparoscopic colorectal resection for endometriosis: preliminary results. Fertil Steril 84,945–950.

Darai E, Thomassin I, Barranger E, Detchev R, Cortez A, Houry S and Bazot M (2005a). Feasibility and clinical outcome of laparoscopic colorectal resection for endometriosis. Am J Obstet Gynecol 192,394–400.

Delpy R, Barthet M, Gasmi M, Berdah S, Shojai R, Desjeux A, Boubli L and Grimaud JC (2005). Value of endorectal ultrasonography for diagnosing rectovaginal septal endometriosis infiltrating the rectum. Endoscopy 37,357–361.

Dubernard G, Piketty M, Rouzier R, Houry S, Bazot M and Darai E (2006). Quality of life after laparoscopic colorectal resection for endometriosis. Hum Reprod 21,1243–1247.

Fauconnier A, Chapron C, Dubuisson JB, Vieira M, Dousset B and Breart G (2002). Relation between pain symptoms and the anatomic location of deep infiltrating endometriosis. Fertil Steril 78,719–726.

Fedele L, Bianchi S, Raffaelli R and Portuese A (1997). Pre-operative assessment of bladder endometriosis. Hum Reprod 12,2519–2522.

Fedele L, Bianchi S, Portuese A, Borruto F and Dorta M (1998). Transrectal ultrasonography in the assessment of rectovaginal endometriosis. Obstet Gynecol 91,444–448.

Fedele L, Bianchi S, Zanconato G, Bettoni G and Gotsch F (2004). Long-term follow-up after conservative surgery for rectovaginal endometriosis. Am J Obstet Gynecol 190,1020–1024.

Fedele L, Bianchi S, Zanconato G, Berlanda N, Borruto F and Frontino G (2005). Tailoring radicality in demolitive surgery for deeply infiltrating endometriosis. Am J Obstet Gynecol 193,114–117.

Jenkins S, Olive DL and Haney AF (1986). Endometriosis: pathogenetic implications of the anatomic distribution. Obstet Gynecol 67,335–338.

Kinkel K, Chapron C, Balleyguier C, Fritel X, Dubuisson JB and Moreau JF (1999). Magnetic resonance imaging characteristics of deep endometriosis. Hum Reprod 14,1080–1086.

Koninckx PR and Martin D (1994). Treatment of deeply infiltrating endometriosis. Curr Opin Obstet Gynecol 6,231–241.

Koninckx PR, Meuleman C, Demeyere S, Lesaffre E and Cornillie FJ (1991). Suggestive evidence that pelvic endometriosis is a progressive disease, whereas deeply infiltrating endometriosis is associated with pelvic pain. Fertil Steril 55,759–765.

Koninckx PR, Oosterlynck D, D'Hooghe T and Meuleman C (1994). Deeply infiltrating endometriosis is a disease whereas mild endometriosis could be considered a non-disease. Ann N Y Acad Sci 734,333–341.

Nishimura K, Togashi K, Itoh K, Fujisawa I, Noma S, Kawamura Y, Nakano Y, Itoh H, Torizuka K and Ozasa H (1987). Endometrial cysts of the ovary: MR imaging. Radiology 162,315–318.

Nisolle M and Donnez J (1997). Peritoneal endometriosis, ovarian endometriosis, and adenomyotic nodules of the rectovaginal septum are three different entities [see comments]. Fertil Steril 68,585–596.

Ohba T, Mizutani H, Maeda T, Matsuura K and Okamura H (1996). Evaluation of endometriosis in uterosacral ligaments by transrectal ultrasonography. Hum Reprod 11,2014–2017.

Outwater EK, Siegelman ES, Chiowanich P, Kilger AM, Dunton CJ and Talerman A (1998). Dilated fallopian tubes: MR imaging characteristics. Radiology 208,463–469.

Reich H, McGlynn F and Salvat J (1991). Laparoscopic treatment of cul-de-sac obliteration secondary to retrocervical deep fibrotic endometriosis. J Reprod Med 36,516–522.

Roseau G, Dumontier I, Palazzo L, Chapron C, Dousset B, Chaussade S, Dubuisson JB and Couturier D (2000). Rectosigmoid endometriosis: endoscopic ultrasound features and clinical implications. Endoscopy 32,525–530.

Siegelman ES, Outwater E, Wang T and Mitchell DG (1994). Solid pelvic masses caused by endometriosis: MR imaging features. AJR Am J Roentgenol 163,357–361.

Takahashi K, Okada S, Ozaki T, Kitao M and Sugimura K (1994). Diagnosis of pelvic endometriosis by magnetic resonance imaging using "fat-saturation" technique. Fertil Steril 62,973–977.

Togashi K, Nishimura K, Itoh K, Fujisawa I, Noma S, Kanaoka M, Nakano Y, Itoh H, Ozasa H, Fujii S, *et al.* (1988). Adenomyosis: diagnosis with MR imaging. Radiology 166,111–114.

Togashi K, Nishimura K, Kimura I, Tsuda Y, Yamashita K, Shibata T, Nakano Y, Konishi J, Konishi I and Mori T (1991). Endometrial cysts: diagnosis with MR imaging. Radiology 180,73–78.

Volpi E, Ferrero A and Sismondi P (2004). Laparoscopic identification of pelvic nerves in patients with deep infiltrating endometriosis. Surg Endosc 18,1109–1112.

Submitted on May 23, 2006; resubmitted on June 29, 2006; accepted on July 3, 2006