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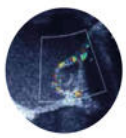

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The IDEAL study: MRI for suspected deep endometriosis assessment prior to laparoscopy is equally reliable as radiological imaging as a complement to transvaginal ultrasonography

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Short title: Preoperative staging of endometriosis by MRI

Contribution

What are the novel findings of this work?

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According to the ESHRE recommendations, TV-US and additional imaging is mandatory to assess ureter, bladder, bowel and abdominal organs involvement if case of suspected deep endometriosis. Although the role of MRI in the diagnostic work-up is clear, our paper evince the value of a one-stop abdominal MRI in the preoperative patient stratification.

What are the clinical implications of this work?

The use of a one-stop abdominal MRI in the preoperative assessment of patients scheduled for endometriosis surgery eliminates the adverse effects of the ionizing radiation and contrast administration of an IVU and DCBE, and reduces the overall diagnostic work-up time.

Abstract

Objectives: this prospective observational study compared the value of magnetic resonance imaging (MRI) complementary to transvaginal ultrasonography (TV-US) to our standard preoperative assessment of patients with endometriosis referred for surgery in a tertiary care academic center.

Based on the extent to which endometriosis affects reproductive organs, bowel, ureters, bladder or other abdominal organs, the surgery will be carried out by gynecologists only or by a multidisciplinary team involving abdominal surgeons and/or urologists.

Methods: In 74 women with clinically suspected deep endometriosis (DE) the standard preoperative imaging, i.e. an expert transvaginal ultrasonography (TV-US), complemented by an intravenous urography (IVU) for the evaluation of the ureters, and a double contrast barium enema (DCBE) for the evaluation of the rectum, sigmoid and caecum was compared with an expert TV-US complemented by a 'one-stop' abdominal and pelvic magnetic resonance imaging (MRI). The findings of the laparoscopy were the reference standard to provide an answer to the question if a 'one-stop' abdominal/pelvic MRI is equally reliable as our standard radiological imaging as a complement to transvaginal ultrasonography for preoperative triaging of patients with suspected urological and intestinal involvement by DE in tertiary care centers.

Results:

The standard preoperative imaging as well as the combined findings of the TV-US and the MRI allowed a correct stratification for a monodisciplinary approach by gynecologists or a multidisciplinary approach in 90.5% of the patients. Both TV-US and DCBE underestimated the severity of the rectal involvement in 2.7%, whereas TV-US and/or DCBE overestimated it in 6.8% of the patients.

Conclusions:

In conclusion, complementary to an expert transvaginal ultrasound (TV-US) a 'one-stop' magnetic resonance imaging (MRI) predicts the intra-operative findings equally well as the standard radiological imaging (IVU and DCBE) in patients referred for endometriosis surgery in a tertiary care academic center.

Introduction

Endometriosis has a high prevalence in women of reproductive age, related to ectopic endometrial-like tissue, producing a chronic inflammation with chronic pelvic pain, dysmenorrhea, deep dyspareunia, dysuria, dyschesia, chronic fatigue, and subfertility. The prevalence of endometriosis in these women is around 10% [1], and even higher in infertile women (35% [1]) and women with pelvic pain (>33% [2]).

Endometriosis has an important economic impact due to the direct costs of diagnosis and treatment and indirect costs related to absenteeism and lost productivity [3], at least as high as those related to Crohn disease or migraine [3-5].

The American Society of Reproductive Medicine (ASRM) [6] defines different stages, depending on peritoneal lesions, ovarian endometriomas, adhesions and deep endometriosis (DE). The proportion of these stages may vary in different populations [7, 8].

The European Society of Human Reproduction and Embryology (ESHRE) states that endometriosis is diagnosed during laparoscopy, ideally with histological confirmation [9, 10]. In women with symptoms and signs of pelvic endometriosis, TV-US can identify or rule out extragenital and rectal endometriosis [11]. Additional imaging is advised to assess ureter, bladder, bowel and abdominal organs involvement if suspicion of DE, allowing surgery planning by a gynecologist or by a multidisciplinary team supported by urologists and/or abdominal surgeons.

First line preoperative imaging consists of a TV-US for all patients with suspected pelvic pathology and/or endometriosis. In case of (suspected) DE, ureteric involvement [9] is evaluated by an IVU, involvement of the colon by a DCBE [12, 13] or CT colonography (CTC) [14-16]. More recent guidelines recommend MRI as the second line preoperative imaging [17, 18].

Although many use MRI to diagnose endometriosis, to detect hemorrhagic and infiltrating lesions, and to estimate the pelvic [19-21] and bowel involvement [22-32], we performed MRI only according to the discretion of the gynecologist. We performed retrograde opacification of the vagina and the rectum for better delineating the vaginal and rectal wall which form the Douglas pouch [25, 33-38]. Given the promising results of MRI in staging endometriosis [19, 39-41] , our study evaluated MRI as a non-invasive and non-ionizing complement to TV-US for the preoperative staging.

Methods

Study design

The IDEAL study (MR Imaging for Deep Endometriosis Assessment prior to Laparoscopy) is a single center prospective study comparing the standard preoperative imaging in our institution i.e. TV-US, complemented with an IVU for the evaluation of the ureters, a DCBE for evaluation of the rectum, sigmoid and caecum, and a case-based pelvic MRI, with TV-US complemented with an abdominal and pelvic MRI in women with clinically suspected DE. The findings from the laparoscopy were used as the reference standard. The study was approved by the Ethics Committee of the KU Leuven University Hospitals (24/5/2013): all participants who agreed to participate have signed a written informed consent. The IDEAL study was registered and published on the public site of ClinicalTrials.gov, a service of the U.S. National Institutes of Health, with identifier NCT01939535 'Preoperative staging of endometriosis with MRI (IDEAL)'. As this study concept reflects our clinical practice for the preoperative patient assessment at that moment, it does not take into consideration the recent published newer guidelines [17, 18, 42].

We compared the diagnostic accuracy of DCBE with the accuracy of the MRI using a McNemar test, since the bowel wall assessment is of utmost importance. In a 2x2 table with different variables, the proportion of both a correct DCBE and MRI was estimated to be 72.5%, 12.5% for an incorrect DCBE but correct MRI, 2.5% for a correct DCBE but incorrect MRI, and 12.5% for an incorrect DCBE and MRI. The presumed accuracy was 75% for the DCBE and 85% for the MR. These figures and prepositions were based on the performance of the preoperative DCBE in our institution [43] and the MR capability to distinguish the individual layers of the bowel wall as known from rectal cancer imaging studies [44-47] and endometriosis [25]. Given these presumptions and a significance level of 0.05, the minimally required sample size was calculated to be 64. A total of 120 patients were invited to participate in the study to anticipate the risk of dropout. Exact 95% confidence intervals [48] were constructed for the difference in percentage correct evaluations between the two approaches. Analyses were performed using the package StatXact Version 9.0.0. A McNemar test calculated the statistical significance of these differences.

Data Collection

For this purpose, we collected the following imaging information prior to surgery and compared with the intraoperative findings: the impact of endometriosis on gynecological structures, the involvement of the wall of the recto-sigmoid, the ureters and the bladder wall and elsewhere in the abdomen (Table 1).

Patient groups and selection of patients

All premenopausal symptomatic patients, aged between 18 and 50, with a likely diagnosis of endometriosis and in whom a potential surgical intervention was planned were eligible to participate in this trial. Suspicion of endometriosis was based on the patient's history, physical examination and/or a previous gynecological ultrasonography. MRI exclusion criteria included any contra-indication for an MRI examination (e.g. pacemaker, other ferromagnetic implants; claustrophobia; patients in poor general clinical condition, pregnancy, contrast allergy).

Flow chart / description of the preoperative imaging examinations:

After a gynecological assessment, all patients scheduled for endometriosis surgery were treated with nomegestrol acetate 5 mg 1 per day (Lutenyl® - Teva), for at least 4 weeks. All preoperative imaging was planned in a 2-week period 5 to 8 weeks after starting the hormonal treatment.

Transvaginal ultrasonography (TV-US)

Although various ultrasound approaches have been published, four basic sonographic steps are proposed to examine women with suspected or known endometriosis to confirm or exclude the different forms of endometriosis [42]. This examination can be performed in most patients in 20-30 minutes.

Double contrast barium enema (DCBE)

The DCBE followed the TV-US on the same day. For bowel preparation, two days prior to the exam, patients were allowed to eat food with low fiber content only and on the evening prior to the exam, food intake was restricted to a liquid meal. Patients were encouraged to drink at least 2 liters of water a day, and to restrict the use of sparkling drinks, fruit juice, alcohol, coffee and tea. Finally, at 18:00 and again prior to going to sleep, macrogol 100 g and ascorbic acid 4.7 g + sodium ascorbate 5.9 g (Moviprep® -Norgine) in one liter of water was ingested. The fluoroscopy guided DCBE, using barium and insufflated air, allows to analyze the luminal contour, the barium-coated mucosal surface and the barium pool to detect abnormalities in the colon. With a careful technique, a high-quality

examination can be performed in most patients in 20-30 minutes with a radiation dose between 1.05-5.05 mSv [49].

Subsequently, the IVU and abdominal MRI were performed on different days in the 2-week period following the TV-US/DCBE.

Intravenous urography (IVU)

The IVU is designed to optimize depiction of specific portions of the urinary tract during maximal contrast material opacification, and a tailored urographic study provides sufficient diagnostic detail [50]. In case there is no obstruction, this examination can be performed in most patients in 10-15 minutes with a radiation dose around 3 mSv [51, 52].

MR Imaging protocol

All MRI examinations were performed on a 1.5 Tesla scanner (Magnetom Aera, Siemens, Germany), using a body phased array coil.

No bowel preparation was performed for these examinations, although a moderately filled bladder was a prerequisite.

Both the vagina and the rectum were filled with 60-100ml Aquasonic® Ultrasound gel in order to obtain adequate distention and delineation of the vaginal and rectal wall [35-37].

MRI acquisitions (Table 2) include axial and coronal high resolution T2 weighted images of the upper abdomen; sagittal, coronal and axial high resolution T2 weighted images of the pelvis and axial and sagittal T1 weighted turbo spin-echo with fat suppression. Although the use of gadolinium for the diagnosis of DE is not clear [53], we administered intravenous meglumine gadoterate 0.5 mmol/ml (Dotarem® - Guerbet) for the visualization of the urinary excretory system, and in analogy with the technique of the MR colonography [54].. Coronal 3D gradient echo T1 weighted images with fat suppression were performed in the arterial, venous and excretion phase, i.e. when the urinary collecting system, ureters and bladder were opacified. Maximum intensity projections were obtained from a coronal data set of T1 weighted images during the excretion phase (MR excretory urography) [55].

We did not include a static-fluid MR urography without contrast nor furosemide was used given the lack of information regarding eventual hydronephrosis and the risk of decompensation in these cases.

The T1 weighted images with fat suppression are most sensitive for detecting lesions that contain blood, whereas high-resolution T2 weighted images are most sensitive to detect and characterize 'fibrotic' lesions . The combined use of T1 and T2 weighted images is of added value to detect endometriomas due to the characteristic "shading" features of these lesions. This MR technique is similar to the technique described in a recent review paper on preoperative staging of endometriosis [10].

The estimated examination time was around 40 minutes.

Diagnostic Criteria of DE

Histology

In the event of DE, endometrial glands and stroma extend at least 5 mm into the subperitoneal tissues inducing fibrosis as well as hyperplasia and hypertrophy of smooth muscle fibers. Macroscopically DE implants result in irregular soft tissue nodules and plaques. Microscopically, DE implants contain endometrial stroma and glands together with fibrosis, and combined corresponding hyperplasia and hypertrophy of smooth muscle fibers.

Transvaginal ultrasonography (TV-US)

These soft tissue nodules and plaques, together with the fibrosis lead to the fixation of pelvic organs with reduced mobility, resulting in an absent 'sliding sign' of the anterior or posterior compartment in case of obliteration of the vesico-uterine or the Douglas pouch respectively [11, 56-58]. When the rectal wall is involved, a mass with band-like extensions may be seen, resembling a 'moose antler' [59], formerly also indicated as an 'Indian head dress' [60], which suggests invasion of the mucosa or submucosa (Fig 1). All these structural abnormalities are called hard markers. Endometriomas typically present as ovarian cysts with ground glass echogenicity, and one to four compartments without papillary structures [61]. Besides the use of the hard markers the identification or exclusion of pelvic pathology in women with chronic pelvic pain - as is the case in patients with endometriosis - can be enhanced by incorporating soft markers, e.g. ovarian mobility or localized peritoneal fluid. Even more important is the value of tenderness guided ultrasonography" in the detection of DE, by which application of pressure by the ultrasound probe on the suspected DE nodules causes site specific tenderness [58, 60]. Further, the detection of distal ureter dilatation is possible on a transvaginal scan.

Double contrast barium enema (DCBE)

On a DCBE, various degrees of wall serration are the indirect signs of the mass effect of the DE implants [62, 63]. This serration is due to infiltration of the submucosal and/or muscular layer of the bowel (Fig 2). The combination of a mass effect with serrations in a setting suspicious of large bowel endometriosis corresponds well with DE in the bowel wall.

It is strongly recommended that DCBE is performed in patients with symptoms and signs suggesting DE located in the upper part of the sigmoid, which is less accessible with TV-US [62]. Although a DCBE is rather easy to perform, the results of a DCBE largely depend on both a rigorous technique and operator skill as well as the knowledge and experience of the radiologist [63].

Intravenous urography (IVU)

Intravenous urography (IVU) allows the evaluation of ureteric endometriosis (UTE) [64], but relies on a sufficient renal function. Ureteric involvement is classified as either intrinsic or extrinsic, occurring in a 1:4 ratio [65]. The extrinsic form affects only the adventitia or surrounding connective tissue. The intrinsic form infiltrates the muscular wall, the lamina propria or the ureteric lumen. The two forms may coexist.

Radiological findings include encasement and narrowing or displacement of the pelvic ureter (Fig 3a/3b) and, rarely, an intraluminal ureteric mass. Furthermore, an IVU may show the precise location, extent and degree of ureteric stenosis as well as the degree of possible secondary hydro-ureteronephrosis (Fig 4a). Although abdominal ultrasound is a valid screening tool to detect hydronephrosis due to ureteral obstruction, IVU and MRI are of value to map the extent of disease [66], and to detect any congenital ureteric variants, like duplication of the ureters, which is important to know in case of ureteral stenting or surgery.

Due to time as well as radiation constraints, no full bladder images are taken in our institution. This means that IVU can only detect extensive bladder lesions (Fig 4b).

Magnetic resonance imaging (MRI)

The MR findings and 'imaging pearls' of endometriosis are well described in literature [67, 68]. Multiple T1-hyperintense adnexal cysts are specific for endometriomas due to the presence of blood in the cyst cavity (Fig 5a). This results in a low signal intensity on T2 weighted images, the so-called shading (Fig 5b).

Solid fibrotic masses or nodules of endometriosis present as irregular masses with low signal intensity on T2-weighted images sometimes with punctate high signal intensity on T1-weighted images [69, 70]. They present as hypointense lesions on T2 weighted images that might involve the gynecological structures, the rectosigmoidal wall, the ureters or bladder wall.

Endometriotic bowel implants are typically located at the anti-mesenteric bowel wall, and present as extrinsic masses: a thickened bowel wall with nodules and hypointense plaques on T2 weighted images (Fig 6a) in the adjacent fat plane [71], enhancing on T1 weighted images (Fig 6b). The presence of a 'fan shaped' muscular layer in combination with submucosal hyperintensity or a so-called 'mushroom cap' indicates muscular invasion, whereas isolated submucosal thickening not always corresponds to (sub)mucosal invasion [25, 34, 72]. Given the MRI voxel sizes of 0.6 x 0.6 x 5.0 mm (T2 sequences) and 2.0 x 2.0 x 5.0 mm (T1 sequences), the minimal lesion size that can be depicted lies between 1.2 and 4.0 mm in plane, and around 10mm through plane.

Besides bowel involvement, MRI may reveal a nodule or a mass invading the ureter along its course or at the ureterovesical junction. Ureter involvement may arise from isolated lateral pelvic endometriosis or posterior location in the retrocervical area that secondarily invades the ureter. An indirect sign of ureteric involvement is the presence of hydronephrosis above a suspicious lesion (Fig 7) [65]. MRI is operator independent and is capable of depicting the direct signs of invasion or compression of organs, which is not the case in DCBE or IVU. Further, imaging these features relies less on a sufficient renal function, and the diagnostic accuracy of the MRI technique and the ultrasound seem to be similar [73].

Although there might be an association between endometriosis and adenomyosis [74] we will not take into account the findings regarding adenomyosis, since no surgical/histological 'golden standard' was available (no hysterectomies were performed in our patients).

Structured reporting of imaging results

The findings of all the preoperative examinations were recorded and time-stamped in a structured way, using an electronic registration form (supplemental material). In addition to information on the patient and the 'operator', we recorded the results of each examination concerning the involvement of gynecologic (Fig 8a), urologic (Fig 8b), colorectal (Fig 8c) or other abdominal structures (Fig 8d). In particular, the following gynecologic structures were evaluated: the vesicouterine pouch, the vesicovaginal septum, the fallopian tubes, the parametria, the ovaries, the retrocervical area, the

uterus (adenomyosis or congenital malformations), the vagina, the posterior vaginal fornix, the rectovaginal septum, the rectovaginal pouch of Douglas and the uterosacral ligaments. We recorded the number of ureters, their displacement or stenosis, the presence of hydro-ureteronephrosis and peri-ureteral lesions, and external compression, serosal invasion or intramural invasion of the bladder wall. Regarding the rectosigmoidal wall, we recorded external compression, serosal invasion and eventual intramural invasion (muscular layer and beyond). Finally, we recorded lesions of the diaphragm, the abdominal wall and other structures not mentioned above.

Wherever possible, we staged the invasion into the bowel or bladder: non or serosal invasion, invasion of the muscular layer (muscularis propria) or invasion of the submucosa. This mapping of imaging results is comparable to a published ultrasound mapping system for the management of deep endometriosis [75]. For lesions involving the rectal wall, we recorded additional information: the distance to the anal orifice in centimeter, the length of the lesion in millimeter and the circumferential extension in percentage.

For the evaluation of ureters and renal excretion system, besides the presence of ureteral multiplicity, the possible degrees of ureteral involvement were recorded as follows: no involvement, ureter displacement, mild or severe dilatation, ureteral encasement or invasion, and hydronephrosis. The abdominal and pelvic ureter segments were scored separately, and for the pelvic ureter an arbitrary distinction was made between the upper, middle and lower 1/3.

To avoid any bias all examinations were reported independently and blinded i.e. without knowledge of the findings of other examinations. To reassure the same interpretation criteria during the whole study period, we consulted no surgery results prior to the end of the study, i.e. after the surgery of the last patient. For every examination, we used a separate registration form containing only the information of this examination. After submission, the score sheets were no longer accessible to the above-mentioned 'operators'. An independent co-worker not involved in the imaging nor surgery monitored all the preoperative results for availability and completeness.

An expert gynecologist with > 15 years of experience in gynecological ultrasonography performed and reported all TV-US examinations.

Radiologists with 5-10 years of experience in urological radiology performed and reported all the IVU examinations and the urologic part of the MRI examinations, with the restriction that the same radiologist never reported the IVU and MRI of the same patient.

A trainee performed all the DCBE whereas radiologists with 5-20 years of experience in abdominal radiology reported all the DCBE.

A radiologist with >15 years of experience in abdominal radiology reported all MRI examinations.

For all these examinations, all readers were blinded to the results of the other examinations of the same patient (TV-US, IVU, DCBE and MRI).

The clinical findings, and the worst-case scenario, i.e. the highest degree of organ involvement on the TV-US, DCBE or IVU (bladder, ureters, gynecological structures and rectosigmoid) guided the decision to plan a surgical treatment by gynecologists only or by a multidisciplinary team. The estimated theatre time reflects the severity of the disease.

Since the gynecologist was unaware of the MRI findings until the end of the laparoscopic intervention, the MRI results did not serve as a decision maker for the patient stratification and corresponding treatment. Diagnostic procedures without or with minor surgery were performed in a one-day surgery setting; the foreseen intervention times are 2 or 3 hours (DAY).

Patients with predicted severe disease were admitted to hospital with a scheduled maximal theatre time of 3 hours for a monodisciplinary approach (HOS3), 6 hours in case of the risk of bowel resection (HOS6), and 8 hours in case of the risk of bowel resection and ureter reimplantation (HOS8).

Structured reporting of intraoperative results

The technique used in our institution for cases that are treated multidisciplinary has been described extensively in literature [12, 43]. Surgery is performed in maximum three steps. During each the operative laparoscopy, the gynecologist first made a detailed description of the findings in the pelvis and staged the endometriosis according to the ASRM [6] and, where applicable, the Endometriosis Fertility Index (EFI) [76] classifications: all visible endometriosis is resected including radical nodulectomy (with/without placement of ureteric stents at the start). In the second and third step (where applicable) evaluation of the ureter/bladder and bowel integrity is done and if necessary further operative procedures are performed by the urologist or the colorectal surgeon respectively. Ureteric stents were placed in all patients scheduled for HOS 6 and HOS 8, given the risk of a 'frozen pelvis' intervention. In patients scheduled for HOS 3, ureteric stents were only placed in case of a large endometrioma, given the risk of ureteric damage during the peeling of the peritoneum in

the iliac fossa. Further, ureteric stents were placed in all cases were the IVU indicated peri-ureteral endometriosis and/or medial displacement of the ureters. This means that the decision for either partial/full thickness disc excision (excision by gynecologist, suture by colorectal surgeon) or segmental resection concerning lesions infiltrating the colon is taken intra-operatively. The decision for segmental resection is taken in the following conditions: large direct full-thickness trauma too extensive to be sutured, extensive lesion to the bowel wall musculature in the absence of full-thickness damage but with impact on functionality, and extensive lateral dissection compromising the colorectal wall vascularization and/or innervation.

Radical excision of endometriosis was performed using a CO_2 laser (Lumenis Inc., USA: Compact 40C CO_2 RBMOnline® laser) in the 15 W Super Pulse mode, with resection of endometriotic adhesions and endometriotic cysts, excision of diseased peritoneum and radical nodulectomy. To perform a radical nodulectomy, an incision is made in healthy peritoneum surrounding the diseased peritoneum, followed by 'peeling' off the affected peritoneum with restoration of normal anatomy. During this procedure, the muscular layer of bladder and/or bowel is possibly 'peeled off' the mucosa. The completeness of this procedure is monitored visually and by touching the indurations with the rinsing/aspiration probe. The gynecologist sutured any perforation of the vagina laparoscopically in case of full thickness excision of the posterior wall [12].

The findings of all surgical intervention were recorded in a structured way, using the same electronic registration form that was used for the preoperative imaging. After submission, the score sheets were no longer accessible to surgeons. An independent co-worker not involved in the imaging nor surgery monitored all the surgery results for availability and completeness.

Being blinded for the MRI results, the gynecologist could possibly miss lesions that were only detected on MRI. Since it would be unethical to risk an incomplete treatment due to blinding, the MRI findings were unblinded once the surgeon had completed the electronic registration form on the operative findings. In that way, the surgeon could check whether a lesion seen on MRI was truly present or not and could remove it if necessary. According to the protocol, a lesion seen on MRI and visualized after unblinding was considered as a false negative for laparoscopy. On the other hand, a lesion not found by laparoscopy following unblinding was considered as a false positive for MRI.

The true positive results from the laparoscopy resulted in the reference standard.

Taking into account these definitions of false-negative and false-positive findings, we evaluated the per-patient results as the correctness of the preoperative stratification (DAY, HOS3, HOS6 or HOS8) based on the clinical findings and the results of the standard radiologic imaging (TV-US, DCBE and IVU) versus the preoperative stratification based on the clinical findings and the results of the TV-US and MRI. To facilitate this evaluation, the imaging data from TV-US, IVU, DCBE and MR were converted into a classification using the terms "Underestimation", "Correct" or "Overestimation". Further, the gynecologists could indicate the concordance or discordance between the preoperative imaging and the surgical findings, and whether the MRI findings might have changed their approach in hindsight (Figure 8e).

Since the patient based evaluation and stratification rely strongly on the correct evaluation of the individual organ systems, we compared the correctness of the TV-US, DCBE, IVU and MRI description of the extent of endometriosis with the surgical description of the extent of endometriosis in the gynecological structures, the wall of the recto-sigmoid, the ureters, the bladder wall and elsewhere in the abdomen.

Results

From 20/2/2014 to 23/11/2015, 120 women (ages 19 - 42 years, mean age 32 years) were invited to participate in the study, and all gave written informed consent. Due to intolerance to Lutenyl® (n=4), planning problems of the exams within a 2-week period or in a reasonable time (n=4), claustrophobia (n=3), unwillingness to undergo a planned exam or future surgery (n=15), or other reasons (n=10), 36 patients were excluded from further participation to the study.

The remaining patients (n=84) underwent all preoperative imaging exams. Although intended to take place in a 2-week time frame 5 to 8 weeks after starting the nomegestrol, the mean delay between the start of the nomegestrol and the TV-US was 106 days (range 28 – 343 days) and 104 days (range 31 – 332 days) between the start of the nomegestrol and the MRI. Ten patients did not undergo surgery, mostly due to improvement of the clinical symptoms and/or patient preferences (Fig. 9).

In total, 74 patients were scheduled for surgery based on the clinical findings and the results of the TV-US, IVU and DCBE, in particular the involvement of the bladder, ureters, gynecological structures and rectosigmoid.

The risk of a bowel resection was judged based on either the TV-US or the DCBE findings. Six patients were scheduled for one-day surgery (DAY), 24 patients were scheduled for a monodisciplinary approach (HOS3), and 44 patients were scheduled for a multidisciplinary approach with a risk of bowel resection (HOS6).

Based on the results of the IVU, no patients needed to be scheduled for a multidisciplinary approach with a ureter reimplantation (HOS8).

The surgeries were performed 327 days (range 112 – 647 days) after the start of the hormonal treatment and 223 days (range 43 – 536 days) after the MRI exam.

The results of the surgical interventions allowed evaluating the per-patient correctness of the preoperative stratification based on the combined findings of the clinical examination, the results of the TV-US, DCBE and IVU.

For all stratification groups together, 67 referrals were correct (90.5%), the severity of the disease of two patients was underestimated (2.7%), whereas the severity of the disease of five patients was overestimated (6.8%). Per stratification group, all six referrals for a one-day intervention (DAY) were correct (100%). Of the 24 referrals for a monodisciplinary approach (HOS3), 23 referrals (95.8%)

were correct; the TV-US overestimated the bowel involvement in one patient (4.2%). Of the 44 referrals for a multidisciplinary approach (HOS6), the referrals were correct in 38 patients (86.4%): two referrals were based solely on the results of the DCBE, and 36 referrals were based on the combined results of the TV-US and DCBE. Although both the TV-US and the DCBE underestimated the severity of the disease in two patients, this had no influence on the referral since in these patients either TV-US or DCBE indicated at least one bowel location of DE. The degree of the disease was overestimated in four patients based on the results of the TV-US or the DCBE, leading to the unnecessary planning of a multidisciplinary approach (HOS6). The correct referrals would have been a one-day intervention (DAY) (n=1) and a monodisciplinary approach (HOS3) (n=1). The two other patients nevertheless required a multidisciplinary approach (HOS6) based on other findings not reported on TV-US or DCBE, or on differences between muscular or submucosal involvement.

Given the question if the combination of the TV-US and a 'one-stop' abdominal MRI could replace the combination of the TV-US and the radiological imaging by IVU and DCBE for preoperative stratification of deep endometriosis, the evaluation of the per-patient correctness of the referrals was repeated based on the findings of the TV-US and the MRI.

All the referrals for a one-day intervention (DAY), for a monodisciplinary approach (HOS3) or for a multidisciplinary approach (HOS6) were the same for all the patients, i.e. all groups contained exact the same patients. However, there were individual differences between the estimation of the severity of the disease by DCBE and MRI.

Since the patient-based evaluation and assessment rely strongly on the correct evaluation of the individual organ systems, the results of the surgical interventions also allowed the evaluation and the correctness of the preoperative evaluation of the organ systems based on the results of the TV-US, DCBE, IVU and MRI. The ability to assess the involvement of an organ system depends largely on the specific techniques used (Table 3).

The assessment of the bowel wall involvement, in particular the rectum and sigmoid wall, was done by the TV-US, the DCBE and the MRI. The assessment was correct in 56 patients (75.7%) for the TV-US, in 62 patients (83.8%) for the combination TV-US/DCBE and in 67 patients (90.5%) for the combination TV-US/MRI.

The laparoscopy revealed rectal or/and sigmoidal wall lesions in 48 patients. In 32 patients, there was only rectal involvement; in two patients, there was only sigmoidal involvement, whereas in 14

patients there was both rectal and sigmoidal involvement. Of the rectal lesions, 33 lesions were located less than 15 cm from the internal anal orifice, whereas 13 lesions were located more than 15 cm from the internal anal orifice.

Of the rectal/sigmoidal wall lesions detected at laparoscopy, in 34 patients the TV-US and/or DCBE detected a lesion, meaning that in 14 patients no lesion was detected preoperatively by the standard combination (rectum (n=13) and sigmoid (n=1)). Of these lesions, seven were detected by the MRI, resulting in a 41/48 detection score (85.4%).

In two patients with important bowel wall DE lesions (at least muscular invasion on laparoscopy), findings were false negative: a perceptual error for one patient on DCBE, and incomplete filling of the bowel for one patient on MRI. Both lesions were located at a distance > 15 cm from the internal anal orifice.

Of the 26 patients without any bowel involvement at laparoscopy, there were false positive findings in five patients: one on TV-US, three on DCBE and one on both TV-US and MRI. These results are in favor of choosing TVUS as the first line examination and MRI as a second line examination in line with previous published publications.

Further laparoscopy detected the involvement of the appendix (n=6) and of the terminal ileum (n=1). None of the other imaging modalities detected any of these lesions.

The assessment of the involvement of the gynecological structures (vagina, uterus, ovaries …) was done by the TV-US and the MRI. The assessment of DE lesions was correct in 65 patients (87.8%) for the TV-US and in 67 patients (90.5%) for the MRI. Regarding especially lesions in the posterior vaginal fornix, MRI was false negative in 12 patients, false positive in 1 patient whereas the TV-US was false negative in 1 patient.

Endometriomas were present in 22 ovaries in 14 patients: three unilateral left, three unilateral right and eight bilateral. The endometriomas were detected during LAP in two patients, during LAP and on MRI in two patients, and during LAP, on TV-US and MRI in 10 patients.

The assessment of the involvement of the bladder was done by the TV-US and the MRI. Since in our institution no full bladder images are taken during IVU, we did not assess the bladder involvement on IVU.

The bladder wall was involved in 10 patients. Although the invasion depth might have been assessed differently (muscular vs submucosal or vice versa), the bladder wall involvement was correctly assessed by the TV-US in six patients, whereas this was not the case with the MRI: the bladder wall involvement was correctly assessed in only two patients and overestimated in one patient.

The assessment of the involvement of the ureters was done by the IVU and the MRI. The assessment of DE lesions was correct in 66 patients (89.2%) for the IVU and in 68 patients (91.9%) for the MRI.

None of the abdominal ureteral segments (left and right) were affected. In one patient, a double ureter at the left side was present and detected by both IVU and MRI.

The pelvic ureteral segments were unaffected in 45 patients; in 2 patients invasion was suggested by MRI and displacement was suggested in 10 patients on IVU and/or MRI.

Pelvic ureteral displacement was present in 28 patients and was detected on IVU in 16 patients. The MRI detected the displacement in an additional 9 patients, resulting in a 25/28 detection score (89.3%). Ureteral displacement was falsely described in two patients on IVU, in four patients on MRI and in two patients on IVU and MRI.

Pelvic ureteral encasement, meaning a narrowing with smooth wall lining, was present in none of the patients at laparoscopy but suggested in three patients on IVU and/or MRI. Pelvic ureteral invasion, meaning a narrowing with irregular wall lining, was present in only one patient at laparoscopy but not detected on IVU and/or MRI.

Of the 74 patients, 73 showed no hydronephrosis; in only one patient, there was no contrast excretion at the right side during IVU, although there was already a double-J stent present. Both IVU and MRI showed mild dilatation of the left ureter in only one patient, whereas laparoscopy showed normal findings. The laparoscopy showed mild dilatation of the right ureter in only one patient, whereas IVU and MRI showed normal findings.

The overall assessment of the involvement of the bowel wall, gynecological structures, bladder and ureters was correct in 50 patients (67.6%) for the combination of TV-US, IVU and DCBE, and in 64 patients (86.5%) for the combination of TV-US and MRI. Although we registered the involvement of a lot of other pelvic and abdominal locations, these locations did not contribute to the patient triage and management.

The MRI was the only technique to allow the assessment of the involvement of other intra-abdominal structures not mentioned above, e.g. small bowel, diaphragm… In one patient, only the MRI-based work-up detected a deep lesion on the diaphragm that was confirmed laparoscopically. Four lesions were not detected on any preoperative work-up, but only during surgery: involvement of the ischio-anal fossa (n=1), small intestine (n=2), and abdominal wall (n=1).

Discussion

The IDEAL study compares our standard preoperative imaging in women with clinically suspected DE, i.e. an expert TV-US, complemented by an IVU for the evaluation of the ureters, and a DCBE for the evaluation of the rectum, sigmoid and caecum with the results of an expert TV-US complemented by a 'one-stop' abdominal and pelvic MRI. The standard preoperative imaging as well as the combined findings of the TV-US and the MRI allowed a correct stratification for a monodisciplinary approach by gynecologists or multidisciplinary approach in 90.5% of the patients. The severity of the rectal involvement was underestimated in 2.7% by both TV-US and DCBE, whereas it was overestimated in 6.8% of the patients by TV-US and/or DCBE.

For all stratification groups together, 67/74 referrals were correct (90.5%) for both the standard as well as the alternative approach (TV-US and MRI). All stratification groups contained exactly the same patients, meaning that a 'one-stop' magnetic resonance imaging (MRI) complementary to an expert transvaginal ultrasonography (TV-US) can be a valid alternative for the preoperative assessment of patients with suspected DE lesions. However, there were individual differences between the estimation of the severity of the disease by DCBE and MRI. These differences might be due to the newly introduced scoring system, which was not part of our reporting in daily practice. Further, the interpretation by the radiologists and the gynecologists might be different, especially regarding the differences between no, muscular or submucosal invasion.

The preoperative evaluation of the bowel and of all organ systems together showed higher success rate using the new approach (expert TV-US and MRI) based on confidence intervals and p-values (McNemar test): we could at least observe a non-inferiority for the combination expert TV-US and MRI, although the study was not powered to prove non-inferiority. The same shortcoming is true for the preoperative evaluation of the gynecological and urological organ systems, since we did not defined the region of non-inferiority ("which difference in percentage is negligible").

Although different papers discuss the value of MRI in the diagnosis and preoperative staging of pelvic endometriosis, our paper attempts to stratify the patients according to their need for a mono- or a multidisciplinary surgical approach, based on the involvement of the bladder, ureters, gynecological structures and rectosigmoid. We recorded not only the pelvic findings, but also the involvement of the diaphragm and other possible pelvic and abdominal locations of DE, but none of these lesions did contribute to the decision for a mono- or multidisciplinary approach.

One of the major advantages of this approach is the radiation benefit, given the total lack of ionizing radiation in MRI, which is in contrast to the IVU and DCBE. Second, regarding at least the non-contrast part of the MR examination, the MRI does not rely on a sufficient renal function, as opposed to the IVU. It also overcomes the inconveniences of the DCBE, which is rather cumbersome for both the patient and the radiologist.

This approach aligns our technique with the new recommendations from ESUR and the International Deep Endometriosis Analysis (IDEA) group regarding the staging of pelvic endometriosis [42, 77]. Furthermore, the MRI evaluates the whole abdominal cavity and shows the direct signs of DE and its consequences on the surrounding tissues, including the upper part of the sigmoid, which is less accessible with TV-US. This advantage is especially true for the involvement of the other organs that tend to escape routine evaluation, e.g. the small bowel, diaphragm or abdominal wall. , in this way adding information about the involvement of important organ systems outside the pelvis which might be of value for the patient triage.

A consensus opinion from the International Deep Endometriosis Analysis (IDEA) group advises the standardization of the TV-US terminology to allow meaningful comparisons between studies in women with an ultrasound diagnosis of endometriosis and to facilitate multicenter research [42].

In line with these recommendations and the proposed ultrasound mapping system for the surgical management of deep endometriosis [75], we used of a uniform scoring system for all aspects of the preoperative assessment, be it the clinical examination, the imaging techniques and the surgery, allowing to cover all possible DE locations in a standardized and structured way.

Although there might be an association between endometriosis and adenomyosis [74], we did not take the findings regarding adenomyosis into account since it had no influence on the preoperative stratification.

Nevertheless, a few flaws need attention. First a better bowel filling e.g. by using saline as an alternative to the ultrasound gel, might improve the evaluation of the proximal rectum and sigmoid, improving the precision of the bowel evaluation, because there seems to be a link between the distance to the anal verge and the missed lesions. Further, although we did not include a static-fluid MR urography without contrast in our protocol, this technique may be a further improvement by eliminating the use of intravenous contrast, and by reducing the examination time. The delay between the preoperative work-up and the moment of surgery (mean 327 days) may have had a

negative effect, but this is applicable to all techniques. As far as our knowledge, no other study mentioned the delay between the imaging and the surgery.

In conclusion, a 'one-stop' magnetic resonance imaging (MRI) plus an expert transvaginal ultrasound (TV-US) predicts the intra-operative findings equally well as compared to the standard radiological imaging plus TV-US for patients referred for endometriosis surgery in a tertiary care academic center, without the need of ionizing radiation or intravenous contrast.

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Figure legends

Figure 1 Deep endometriotic lesion resembling a moose antler (schematic drawing) on transvaginal ultrasonography.

Figure 2 Involvement of the anterior rectal wall on a double contrast barium enema by a deep endometriotic lesion (arrows).

Figure 3 Endometriotic lesions (arrows) involving ureters and bladder on intravenous urography: (a) encasement of the left ureter (*); (b) deviation of the right ureter (*).

Figure 4 Endometriotic lesions (arrows) involving ureters and bladder on intravenous urography: (a) obstruction of the left ureter (*) with hydronephrosis (<); (b) impression on the bladder roof (arrow).

Figure 5 Ovarian endometrioma (arrows) with "shading" on MRI T1 (a) and T2 (b) weighted images.

Figure 6 Involvement of the anterior rectal wall on MRI T2 (a) and T1 (b) weighted images by a deep endometriotic lesion resembling a mushroom (arrows).

Figure 7 Deep endometriotic lesion (arrow) involving the ureters on MRI T2 weighted image: obstruction of the left ureter (*) with hydronephrosis.

Figure 8 Electronic score sheet for data management of the gynecological (a), urological (b), colorectal (c), other abdominal (d) and intraoperative (e) findings.

Figure 9 Patient flowchart from inclusion to surgery.

Impact on the gynecological structures	vesicouterine pouch
	vesicovaginal septum
	fallopian tubes
	parametria
	ovaries
	retrocervical area
	uterus (adenomyosis or congenital malformations)
	vagina
	posterior vaginal fornix
	rectovaginal septum
	rectovaginal pouch of Douglas
	uterosacral ligaments
Impact on the rectosigmoidal wall	external compression
	serosal invasion
	intramural invasion (muscular layer and beyond).
Impact on the ureters	number of ureters
	displacement
	stenosis
	hydro-ureteronephrosis
	peri-ureteral lesions.
Impact on bladder wall	external compression
	serosal invasion
	intramural invasion
Other abdominal localizations	diaphragm
	abdominal wall
	other

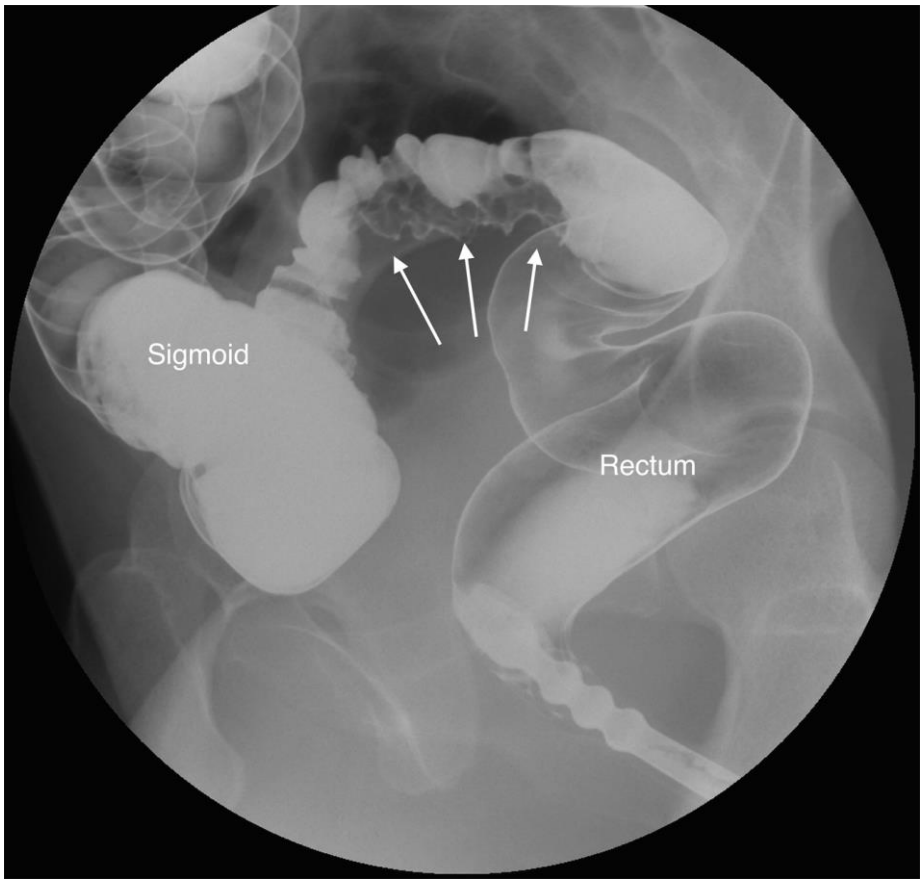
Table 1 Preoperative imaging requests.

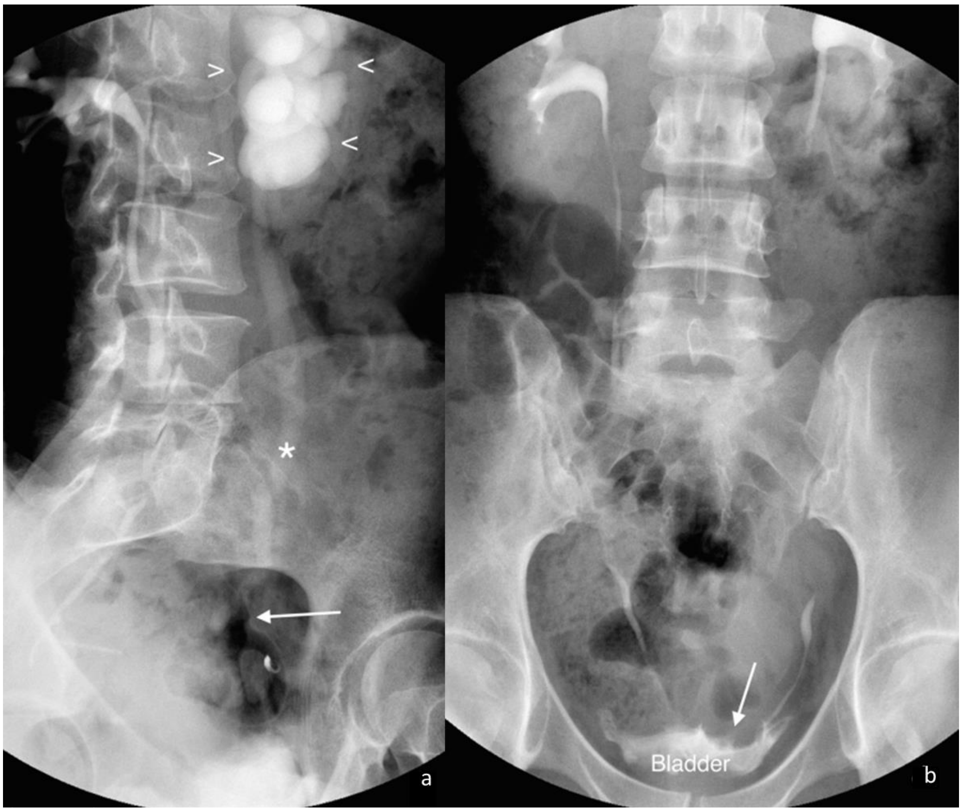
Sequence type	Acquisition plane	Voxel size	Base resolution	Slice thickness	Dist. factor	FoV read	Flip angle	TE	TR	Fat suppr.	Slices
T2 turbo spin echo	sagittal	0.6x0.6x5.0 mm	512	5.0 mm	10 %	320 mm	180 deg	134.0 ms	9760.0 ms	None	22
T2 turbo spin echo	axial	0.6x0.6x5.0 mm	512	5.0 mm	10 %	320 mm	180 deg	134.0 ms	9660.0 ms	None	22
T2 turbo spin echo	coronal	0.6x0.6x5.0 mm	512	5.0 mm	10 %	320 mm	180 deg	134.0 ms	5880.0 ms	None	28
T1 turbo spin echo	axial	0.7x0.7x4.0 mm	512	4.0 mm	0 %	360 mm	180 deg	11.0 ms	650.0 ms	Yes	24
T1 turbo spin echo	sagittal	0.7x0.7x4.0 mm	512	4.0 mm	0 %	360 mm	180 deg	11.0 ms	650.0 ms	Yes	24
T2 turbo spin echo	axial	1.2x1.2x6.0 mm	320	6.0 mm	15 %	380 mm	180 deg	87.0 ms	1000.0 ms	None	35
T2 turbo spin echo	coronal	1.3x1.3x4.0 mm	256	4.0 mm	0 %	330 mm	180 deg	101.0 ms	1400.0 ms	None	50
3D gradient echo T1	coronal	1.1x1.1x1.0 mm	384	1.00 mm	20 %	416 mm	18 deg	1.09 ms	3.16 ms	None	Volume acquisition
T1 turbo spin echo	axial	0.7x0.7x4.0 mm	512	4.0 mm	0 %	360 mm	180 deg	11.0 ms	650.0 ms	Yes	24
T1 turbo spin echo	sagittal	0.7x0.7x4.0 mm	512	4.0 mm	0 %	360 mm	180 deg	11.0 ms	650.0 ms	Yes	24

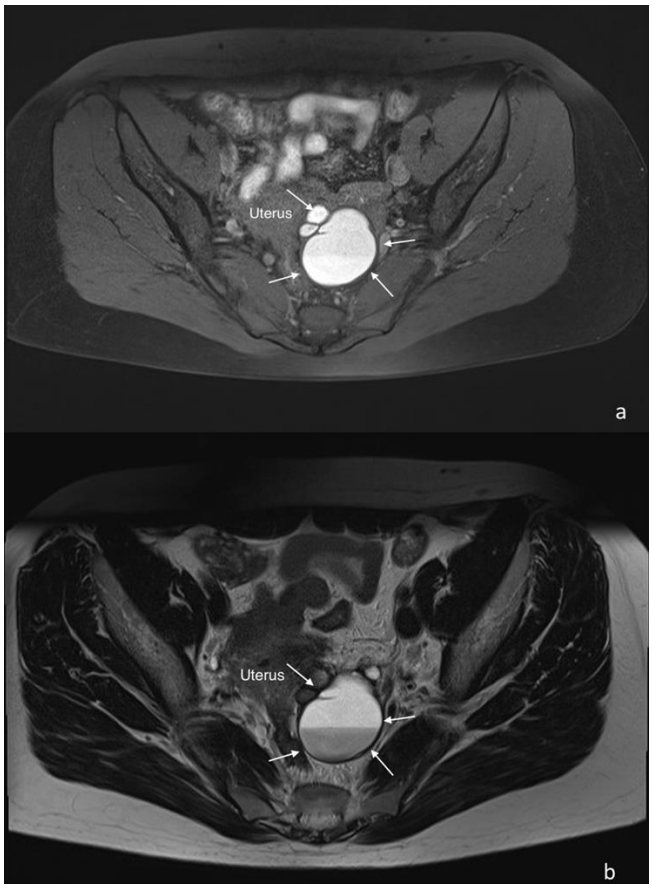
Table 2 Magnetic resonance imaging scan parameters.

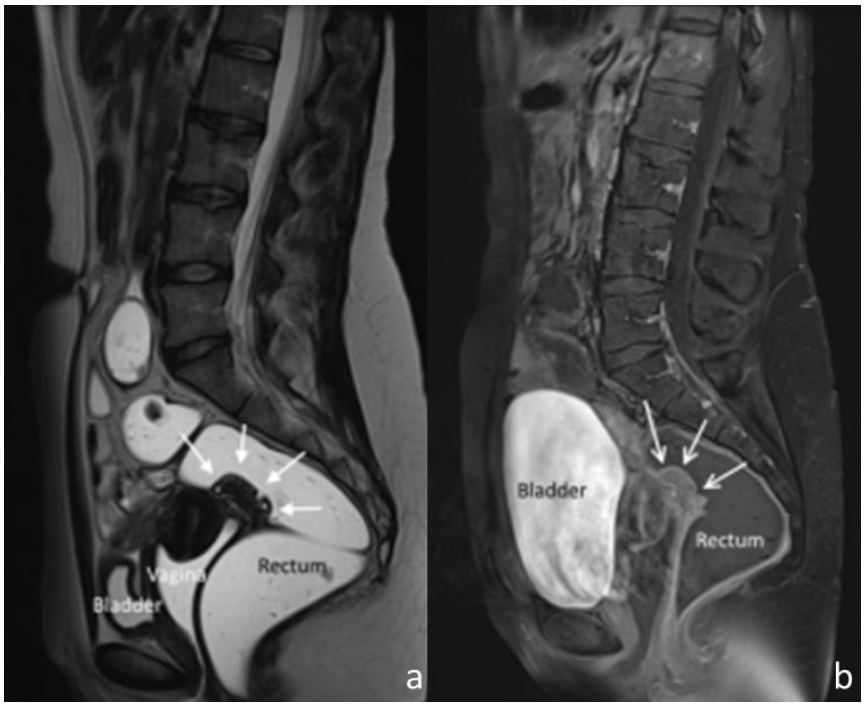
					Percentage correct		Difference (95%CI)	P-value McNemar
Bowel		TVUS/MRI		Total	MRI	TVUS/DCBE		
		-	+					
TV-US/DCBE	-	7	5	12				
	+	0	62	62				
	Total	7	67	**74**	90,50%	83,80%	6.8% (1.1%-15.3%)	0.06
Gynecological structures		MRI		Total				
		-	+					
TV-US	-	2	7	9				
	+	5	60	65				
	Total	7	67	**74**	90,50%	87,80%	2.7% (-7.7% to 13.0%)	0.77
Ureters and bladder		MRI		Total				
		-	+					
IVU	-	2	6	8				
	+	4	62	66				
	Total	6	68	**74**	91,90%	89,20%	2.7% (-6.6% to 12.6%)	0.75
All structures		TVUS/MRI		Total				
		-	+					
TV-US/IVU/DCBE	-	1	23	24				
	+	9	41	50				
	Total	10	64	**74**	86,50%	67,60%	18.9% (3.2% to 33.7%)	0.02

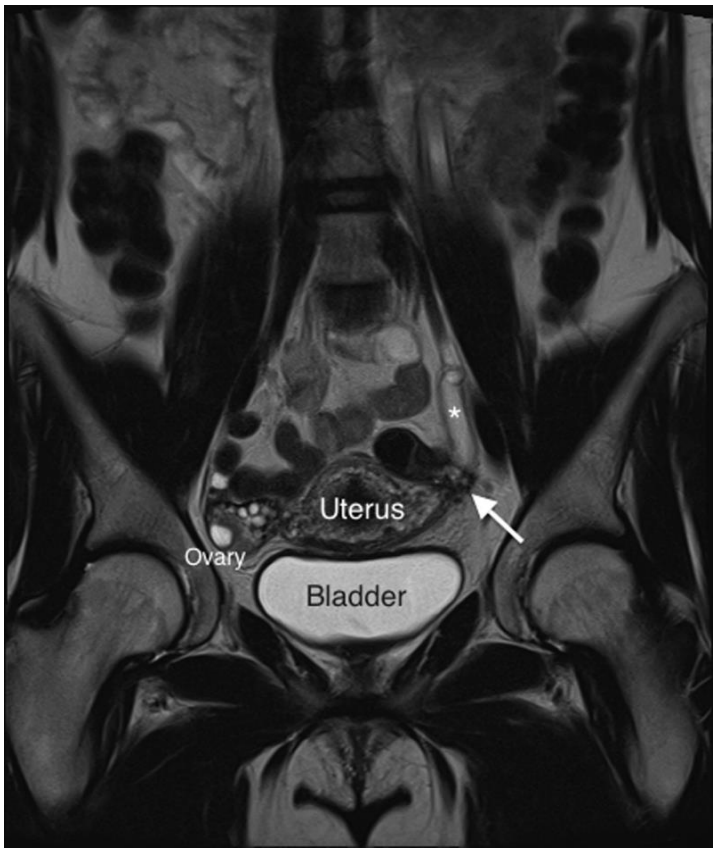
Table 3 Correctness of the organ evaluation by the TV-US, DCBE, IVU and MRI.











Score sheet IDEAL S54441

Involvement of gynaecological structures

Afwijkingen gynaecologische organen

1. **Vesicouterine pouch**
   DIE in vesicouteriene pouch?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

2. **Vesicovaginal septum**
   DIE in vesicovaginale septum?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

3. **Posterior vaginal fornix**
   DIE in achterste vaginale fornix?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

4. **Retrocervical area**
   DIE in retrocervicale area?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

5. **Uterus**
   DIE in uterus?
   Vink alle toepasselijke opties aan.
   - ☐ Adenomyosis
   - ☐ Endometriosis

6. **Parametrium**
   DIE in parametrium?
   Vink alle toepasselijke opties aan.
   - ☐ Right
   - ☐ Left

7. **Fallopian tube**
   DIE in tuba uterina?
   Vink alle toepasselijke opties aan.
   - ☐ Right
   - ☐ Left

8. **Left ovary**
   DIE in linkerovarium?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No
   - ◯ Endometrioma

9. **Right ovary**
   DIE in rechterovarium?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No
   - ◯ Endometrioma

10. **Rectovaginal septum**
    DIE in rectovaginale septum?
    Markeer slechts één ovaal.
    - ◯ Yes
    - ◯ No

11. **Rectovaginal pouch of Douglas**
    DIE in Douglas?
    Markeer slechts één ovaal.
    - ◯ Yes
    - ◯ No

12. **Uterosacral ligaments**
    DIE in uterosacrale ligamenten?
    Vink alle toepasselijke opties aan.
    - ☐ Left
    - ☐ Right

13. **Other gynaecological findings**
    Alleen indien niet hierboven reeds vermeld!

    _____
    _____
    _____
    _____
    _____

a

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Involvement of urological structures

Afwijkingen urinewegen en blaas (IVU of MRI)

1. **Bladder**
   Aantasting blaas (indien mogelijk diepte stadiëren)
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Yes (indeterminate stage)
   - ☐ Serosa (stage 1)
   - ☐ Muscularis (stage 2)

2. **Left excretion system**
   Linkerexcretiesysteem
   Vink alle toepasselijke opties aan.
   - ☐ Single ureter
   - ☐ Multiple ureters
   - ☐ No dilatation
   - ☐ Mild dilatation
   - ☐ Severe dilatation
   - ☐ Anders: .....

3. **Left ureter above promontorium**
   Aantasting linkerureter boven promontorium
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

4. **Left ureter upper 1/3 pelvic segment**
   Aantasting linkerureter bovenste 1/3 pelvische segm
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

5. **Left ureter middle 1/3 pelvic segment**
   Aantasting linkerureter middenste 1/3 pelvische segment
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

6. **Left ureter lower 1/3 pelvic segment**
   Aantasting linkerureter onderste 1/3 pelvische segment
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

7. **Right excretion system**
   Rechterexcretiesysteem
   Vink alle toepasselijke opties aan.
   - ☐ Single ureter
   - ☐ Multiple ureters
   - ☐ No dilatation
   - ☐ Mild dilatation
   - ☐ Severe dilatation
   - ☐ Anders: .....

8. **Right ureter above promontorium**
   Aantasting rechterureter boven promontorium
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

9. **Right ureter upper 1/3 pelvic segment**
   Aantasting rechterureter bovenste 1/3 pelvische segment
   Vink alle toepasselijke opties aan.
   - ☐ Normal
   - ☐ Displacement lateral
   - ☐ Displacement medial
   - ☐ Encasement (smooth wall lining)
   - ☐ Invasion (irregular wall lining)

10. **Right ureter middle 1/3 pelvic segment**
    Aantasting rechterureter middenste 1/3 pelvische segment
    Vink alle toepasselijke opties aan.
    - ☐ Normal
    - ☐ Displacement lateral
    - ☐ Displacement medial
    - ☐ Encasement (smooth wall lining)
    - ☐ Invasion (irregular wall lining)

11. **Right ureter lower 1/3 pelvic segment**
    Aantasting rechterureter onderste 1/3 pelvische segment
    Vink alle toepasselijke opties aan.
    - ☐ Normal
    - ☐ Displacement lateral
    - ☐ Displacement medial
    - ☐ Encasement (smooth wall lining)
    - ☐ Invasion (irregular wall lining)

12. **Other urological findings**
    Alleen indien niet hierboven reeds vermeld!
    .....
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    .....
    .....
    .....

b

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Involvement of colorectal structures

Afwijkingen colon (DCBE of MRI)

1. **Rectum**
   Aantasting rectum (indien mogelijk diepte stadiëren)
   Vink alle toepasselijke opties aan.
   - ☐ Yes (indeterminate stage)
   - ☐ Serosa (stage 1)
   - ☐ Muscularis (stage 2)
   - ☐ Submucosa (stage 3)

2. **In case of rectal involvement**
   Aantasting rectum (locoregionale uitbreiding)
   Vink alle toepasselijke opties aan.
   - ☐ >15 cm from internal anal orifice
   - ☐ <15 cm from internal anal orifice
   - ☐ >50% circumference
   - ☐ <50% circumference
   - ☐ >20 mm length
   - ☐ <20 mm length

3. **Sigmoid**
   Aantasting sigmoid (indien mogelijk diepte stadiëren)
   Vink alle toepasselijke opties aan.
   - ☐ Yes (indeterminate stage)
   - ☐ Serosa (stage 1)
   - ☐ Muscularis (stage 2)
   - ☐ Submucosa (stage 3)

4. **Other colorectal sites?**
   Andere colorectale lokalisaties?
   Vink alle toepasselijke opties aan.
   - ☐ Caecum
   - ☐ Anders: .....

5. **Other colorectal findings**
   Alleen indien niet hierboven reeds vermeld!

   .....
   .....
   .....
   .....
   .....

C

Score sheet IDEAL S54441

Involvement of other abdominal sites

Aantasting andere lokalisaties

1. **Ischioanal or ischiorectal fossa**
   DIE in ischioanale of ischiorectale fossa?
   Vink alle toepasselijke opties aan.
   - ☐ Left
   - ☐ Right

2. **Intestinal loops**
   DIE in dundarm?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

3. **Sciatic nerve**
   DIE op verloop van n. ischiadicus?
   Vink alle toepasselijke opties aan.
   - ☐ Left
   - ☐ Right

4. **Diaphragm**
   DIE op diafragma?
   Vink alle toepasselijke opties aan.
   - ☐ Left
   - ☐ Right

5. **Abdominal wall**
   DIE in de buikwand?
   Markeer slechts één ovaal.
   - ◯ Yes
   - ◯ No

6. **Other abdominal sites?**
   Alleen indien niet hierboven reeds vermeld!

   .....
   .....
   .....
   .....
   .....

d

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Laparoscopic evaluation vs preoperative findings

In hoeverre zijn er afwijkende bevindingen tov de preoperatieve gegevens?

1. **Was the preop judgement underestimation, correct, overestimation?**
   Markeer slechts één ovaal per rij.

	Underestimated	Correct	Overestimated
TVS	◯	◯	◯
DCBE	◯	◯	◯
IVU	◯	◯	◯
MRI	◯	◯	◯

2. **Would MR-findings have changed your laparoscopic approach?**
   Zouden de MR-gegevens uw laparoscopische aanpak veranderd hebben?
   Markeer slechts één ovaal.

   ◯ Yes
   ◯ No

3. **Comments on changes in laparoscopic approach?**

   .....

   .....

   .....

   .....

   .....

e