

STATEMENT

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MRI in female pelvis: an ESUR/ESR survey

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Abstract

Objectives: While magnetic resonance imaging (MRI) is considered the gold standard for the imaging of female pelvis, there is an ongoing debate about the most appropriate indications and optimal imaging protocols. The European Society of Urogenital Radiology (ESUR) launched a survey to evaluate the current utilization of female pelvic MRI in clinical practice.

Methods: The ESUR female imaging subgroup developed an online survey that was then approved by the ESR board and circulated among the ESR members. The questions in the survey encompassed training and experience, indications for imaging and MR imaging protocols, reporting styles and preferences. The results of the survey were tabulated, and subgroups were compared using χ^2 test.

Results: A total of 5900 ESR members with an interest in both MRI and female pelvic imaging were invited to participate; 840 (14.23%) members completed the survey. Approximately 50% of respondents were academic radiologists (50.6%) and nearly 60% women (59.69%). One third of the respondents were subspecialized in Gynecological imaging. Nearly half of the survey participants were aware of the presence of ESUR guidelines for imaging of the female pelvis (47.1%). The adoption of the ESUR recommendations was higher among subspecialized and/or academic and/or senior and/or European radiologists compared to all others. The current ESUR recommendations about female pelvic MRI protocols were generally followed. However wide variations in practice were identified with respect to the use of contrast media.

Conclusion: Female pelvic MRI protocol was generally following the ESUR recommendations, especially among subspecialized and academic radiologists. However, the fact that they are followed by only half of the participants highlights the need for wider awareness of these recommendations.

Keywords: Gynaecology, Magnetic resonance imaging, Practice guideline, Radiologists, Survey and questionnaires

Key points

- The current ESUR recommendations about female pelvic MRI protocols were generally followed.
- ESUR guidelines are used by 48% of the radiologists participating in this survey which highlights the need for greater awareness of these recommendations.

- Subspeciality and/or academic and/or senior and/or European radiologists are most familiar with and are most likely to use these guidelines.

Introduction

Magnetic resonance imaging (MRI) has become the main modality to establish the diagnosis and guide management of patients with gynecological diseases. In oncology, for example, MRI has been incorporated into various clinical guidelines to assess the tumor extent (NCCN, ESMO, FIGO, ESUR, ACR...) [1, 2]. However, the

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indications for MRI of female pelvis vary across societies (NCCN, ESMO, FIGO, ESUR, ACR...) due to regional clinical preferences. Another factors contributing to inter-institutional and international variations are relatively high cost of MRI, limited availability in some locations, and potential reimbursement-related challenges. Further, wide variations exist with respect to MR image acquisition and interpretation. The European Society of Urogenital Radiology (ESUR) published several imaging guidelines including recent updates in the last four years in order to make practice more uniform and up to date among centers and radiologists [3–9]. These updates were prompted by the recent advances in MRI, including increased implementation of functional imaging, i.e. diffusion weighted Imaging (DWI) and dynamic contrast-enhanced MRI (DCE-MRI) [10]. For example, the recent ESUR guideline for the assessment of sonographically indeterminate adnexal masses recommended the use of contrast-enhanced T1WI, preferably using DCE-MRI and time intensity curves for the improved characterization [7]. The use of DWI is now recommended for the evaluation of all gynaecological malignancies [5, 6, 11, 12]. However, while there are consensus guidelines, their knowledge and implementation in clinical practice among radiologists is unknown.

Therefore, the ESUR female pelvis imaging group decided to conduct a survey among the members of the European Society of Radiology (ESR) to gather representative data on current female pelvic MRI practice, patterns of pelvic MRI requests, MRI protocols and to determine how widely these ESUR guidelines have been implemented in routine clinical practice among ESR members.

Materials and methods

Survey design and distribution

Two board certified radiologists (S.N. and R.F.) with 8 and over 25 years of experience in female pelvic imaging developed the survey. It was comprised of 33 questions which included general demographic information, professional training and experience, annual volume of female pelvic MRI examinations; indications and technical details of MRI examinations, and, lastly, reporting habits and preferences. Some questions asked to select all applicable answers; there was no requirement to answer all questions prior to submission. The full questionnaire is available online under the supplement. The survey was first approved by the ESUR female pelvic imaging working group and then by both the ESUR board and the European Society of Radiology (ESR) executive board.

The survey was published online (Survey Monkey www.surveymonkey.de) and announced by the ESUR administrative office via electronic mail. All 5,900 ESR members who previously indicated an interest in both

“Gynaecology and Obstetrics” and “MRI” were invited. The survey opened online on May 7, 2019, and remained active for a 5-week period, with two email reminders sent by the ESUR office during the survey period.

Data analysis

After the survey closed, all responses were extracted and summarized by the ESUR administrative office. In addition, subgroup analyses were performed with the focus on the degree of expertise (gynecological imaging expertise), institution type (academic center vs. other), geographic location (Europe and rest of the world), and years in practice (resident vs. senior). Qualitative variables were described by the number of observations (n) and their frequencies (%). The missing categories were counted. The percentages were calculated in relation with excluded missing data. The χ^2 test, or Fisher's exact test were used for comparisons.

The threshold for significance was set at 5% (i.e. $p=0.05$). Statistical analyses were performed using the R studio v4.0.0 software (2020-04-24).

Results

Among the 5900 ESR members invited to take the survey, 840 returned the survey, i.e., a response rate of 14.23%. Full results of the survey are available as supplementary data.

Internationally, countries with the higher response rates were India ($n=85$), followed by Saudia Arabia ($n=32$), and Pakistan ($n=31$). Among European countries the highest number of answers ($n=34$) were collected from Great Britain and Spain, followed by Romania ($n=30$) and Portugal ($n=20$).

Over half of the participants were practicing in an academic setting (50.6%), nearly 60% were women (59.69%) (Fig. 1), and a third subspecialized in gynecological imaging (Fig. 1).

Indications for female pelvic MRI

The most common indications for MRI were detection and staging of gynecologic neoplasms (80.95%) followed by evaluation of suspected or confirmed recurrent pelvic tumor (78.45%) and sonographically indeterminate adnexal mass (78.21%) (Fig. 2).

MRI protocol

Answers regarding MRI protocols are summarized in Table 1. Most MRI examinations were performed on a 1.5 and/or 3 T units (94.04%). Most radiologists used a tailored protocol as recommended by the ESUR guidelines: T2/T1 sequence covering the paraaortic regions were performed by 70.20%. Oblique sequence perpendicular to the short axis of the uterine corpus or cervix

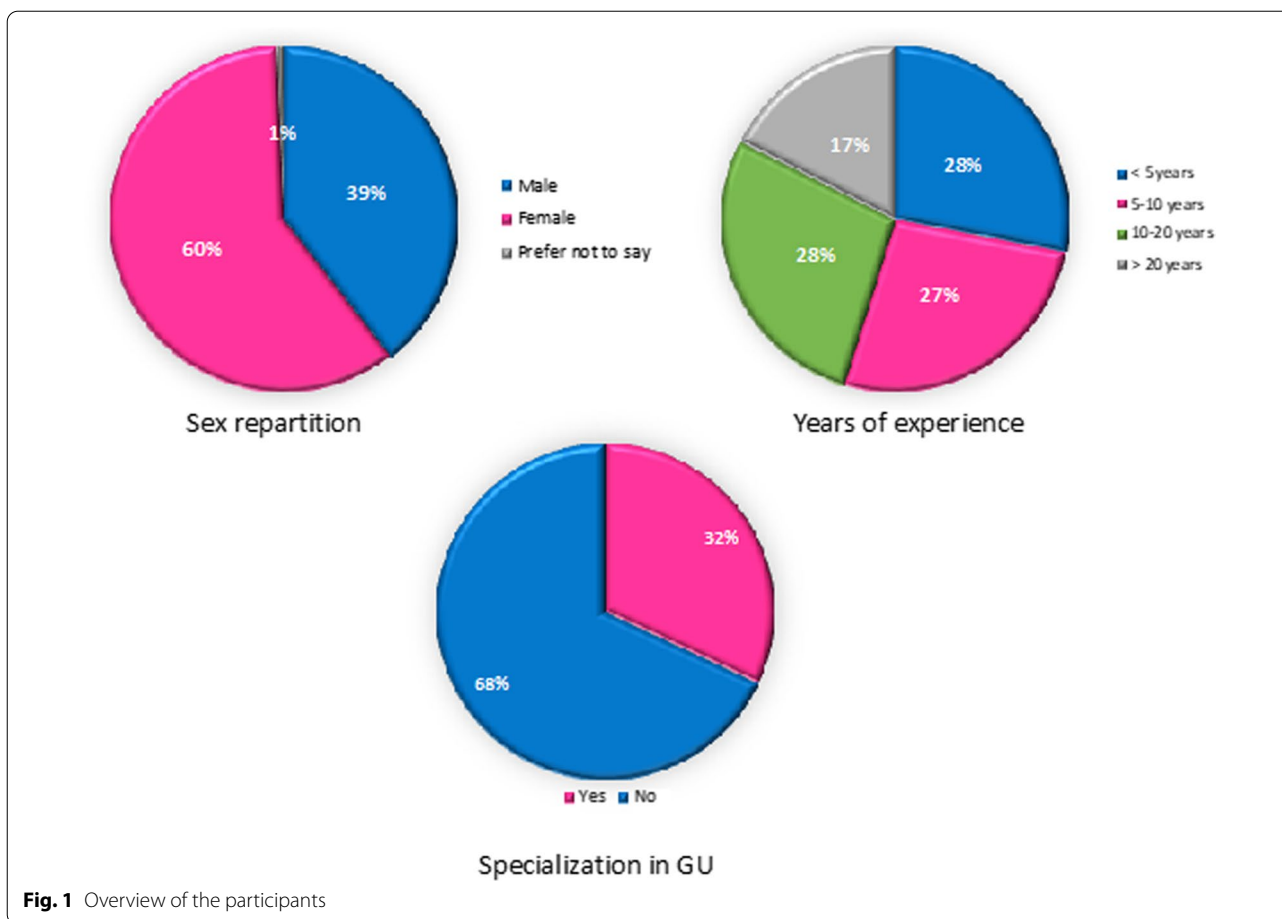


Fig. 1 Overview of the participants

for endometrial and cervical cancer staging, respectively, were performed by 85.23%; slice thickness ≤ 4 mm for axial or axial oblique sequence was used by 64.30%. In contrast, the use of gadolinium-enhanced T1WI FS sequence deviated from the guidelines. (Table 1). For example, only 63.5% of radiologists used contrast-enhanced MR imaging for assessment of a sonographically indeterminate adnexal masses and only 40.12% for evaluation of myometrial masses. DCE MRI was used even less. For example, only 28.93% of radiologists used DCE-MRI in the assessment of a sonographically indeterminate adnexal mass. In contrast, diffusion weighted imaging (DWI) was obtained in 41.31% of female pelvic MRI exams indicating wider adoption compared to DCE-MRI (Table 1). When DWI images were acquired, axial plane was used most often and a high *b* value of ≥ 800 was obtained by 64% of radiologists.

The use of MRI reporting guidelines

This question was not answered by 233 participants. Of 607 respondents, the standardized report was used by 46.29%. Nearly half of the responders were aware of the

presence of ESUR guidelines for imaging of the female pelvis (47.1%). Among them, the reporting guidelines for staging of endometrial and cervical cancer were the most used (69.85% resp. 68.75%) (Table1).

Subgroup analysis

Radiologists subspecialized in gynecological imaging were more likely to be familiar with the ESUR guidelines for imaging of the female pelvis. The use of the recommended axial oblique T2 sequence through the uterus or cervix in case of endometrial or cervical cancer, respectively, and a slice thickness ≤ 4 mm was significantly more used among subspecialized radiologists versus non specialists (oblique axial sequence: 92.24% by specialists vs. 81.57% by non-specialists $p < 0.001$; slice thickness ≤ 4 mm: 87.5% vs. 72.2%, $p < 0.001$). The use of ESUR guidelines was significantly more frequent among specialists versus in non-specialists (63.51% vs. 38.90%; $p < 0.001$) (Table 2). The use of DWI, contrast-enhanced imaging and DCE-MRI was significantly more frequent among sub-specialized versus general radiologists ($p < 0.001$) (Table 2).

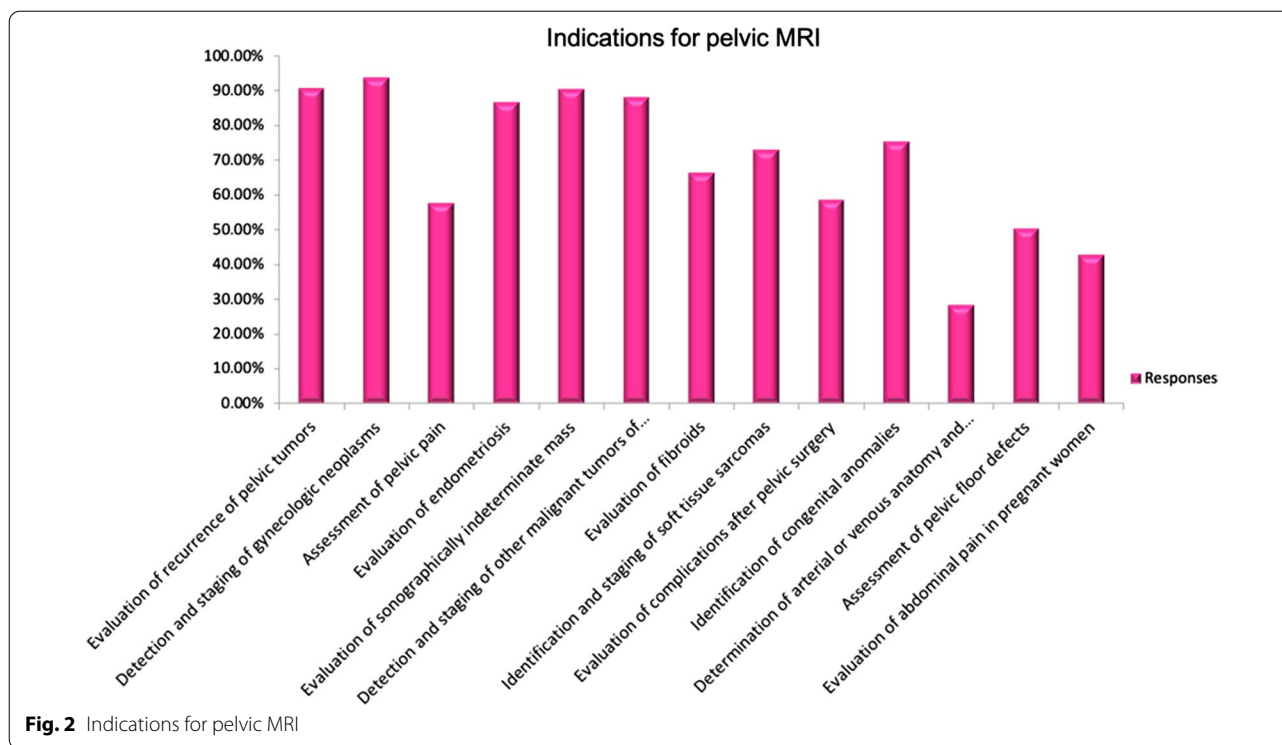


Fig. 2 Indications for pelvic MRI

Women radiologist and gynecological subspecialists were more likely to practice at academic institutions (female vs. male 64.35%/35.19% in academic vs. 54.57%/44.67% in non-academic settings $p=0.01$; specialist in gynecological vs. non specialist 38.82%/61.18% in academic versus 25.19%/74.81% in non-academic practice $p<0.001$). No difference was found in term of the use of MRI protocols between academic and non-academic radiologists except for the use of DWI. The use of DWI was more frequent at academic centers compared to non-academic practices ($p=0.035$). The use of ESUR guidelines was significantly more frequently reported by academic (54.21%) compared to non-academic radiologists (40.85%; $p=0.001$) (Table 3). In contrast, the use of a reporting template was more frequent at non-academic practices (51.75%) compared to academic centers (41.43%; $p=0.011$) (Table 3).

We were interested to determine if there was a difference between Europe, where the guidelines originate from ESR members of non-European countries. Thus, for comparing the practice among radiologists worldwide, due to the relative low number of respondents (or relatively low number of respondents outside of Europe) worldwide the comparisons were made between Europe ($n=376$) and other countries ($n=464$). Interestingly, large differences in terms of imaging protocol were seen. The use of an oblique plane perpendicular to the long axis of the uterus or cervix, a slice thickness <4 mm, the

use of DWI, and DCE-MRI were significantly more frequent in Europe compared the other countries (Table 4). The use of ESUR guidelines was significantly higher among European (63.18%) compared to non-European radiologists (35.06%) ($p<0.001$). In contrast, the use of a reporting template was more frequent in non-European (58.05%) compared to European centers (32.37%; $p<0.001$) (Table 4).

Regarding radiologists' experience, the use of ESUR guidelines were significantly more likely among senior radiologists (50.66%) compared to less experienced radiologists (39.60%) ($p=0.019$). The use of an oblique plane perpendicular to the long axis of the uterus or cervix, DWI, contrast-enhanced imaging, and DCE-MRI were significantly more frequent among senior compared to junior radiologists (Table 5).

Discussion

Nearly half of the radiologists indicated that they were aware of one or more ESUR guidelines. The use of ESUR guidelines was highest among were Senior, academic, GU subspecialized, or European radiologists. The highest use of these guidelines among these subgroups can be explained by recent publications in major radiological journals, educational activities and presentations at subspecialty meetings in Europe. The lower rates among radiologists working in non-academic institutions or among junior radiologists points out the need for more

Table 1 Main result summary

	n = 840
Institution type	
Non-university hospital	393 (49.5)
University hospital	425 (50.5)
NA	22
Gender	
Male	328 (39.71)
Female	493 (59.69)
Prefer not to say	5 (0.61)
NA	14
Experience	
< 5 years	199 (45.33)
5–10 years	108 (24.60)
10–20 years	96 (21.87)
> 20 years	36 (8.20)
NA	401
Indications for pelvic MRI	
Evaluation of recurrence of pelvic tumors	659 (78.45)
Detection and staging of gynecologic neoplasms	680 (80.95)
Assessment of pelvic pain	416 (49.52)
Evaluation of endometriosis	628 (74.76)
Evaluation of sonographically indeterminate mass	657 (78.21)
Detection and staging of other malignant tumors of the pelvis	638 (75.95)
Eval. of fibroids	481 (57.26)
Identification and staging of soft tissue sarcomas	529 (63.00)
Evaluation of complications after pelvic surgery	422 (50.23)
Identification of congenital anomalies	546 (65.00)
Determination of arterial or venous anatomy and patency	205 (24.40)
Assessment of pelvic defects	366 (43.57)
Evaluation of abdominal pain in pregnant women	309 (36.78)
Use of T2/T1 sequence covering the whole paraaortic regions	
Yes	483 (70.20)
No	205 (29.80)
NA	152
Oblique sequence perpendicular to the axis of the uterus or cervix for endometrial or cervical cancer staging	
Yes	577 (85.23)
No	100 (14.77)
NA	163
Slice thickness of axial oblique sequence (< 4 mm)	
Yes	395 (64.30)
No	221 (35.70)
NA	224
Gadolinium T1WI FS sequence	
Yes, in every case	155 (18.45)
No, never	230 (27.38)
Evaluation of recurrence of pelvic tumors	541 (64.4)
In case of detection of gynecologic neoplasms	520 (61.9)
In case of staging of gynecologic neoplasms	530 (63.1)
In case of assessment of a pelvic mass	533 (63.5)
In case of evaluation of fibroids	337 (40.12)
In case of identification of congenital anomalies	176 (21.0)
In case of evaluation of Endometriosis	277 (33.0)
In case of assessment of pelvic floor defects	161 (19.17)
Other	47 (5.6)
Gadolinium cat	

Table 1 (continued)

	n = 840
No, never	230 (27.38)
At least one	455 (54.17)
Yes, in every case	155 (18.45)
Dynamic Contrast enhanced/perfused MRI	
Yes, in every case	65 (7.74)
No, never	473 (56.31)
Evaluation of recurrence of pelvic tumors	238 (28.33)
In case of detection of gynecologic neoplasms	258 (30.71)
In case of staging of gynecologic neoplasms	267 (31.79)
In case of assessment of a pelvic mass	243 (28.93)
In case of evaluation of fibroids	127 (15.12)
In case of identification of congenital anomalies	69 (8.21)
In case of evaluation of Endometriosis	90 (10.71)
In case of assessment of pelvic floor defects	71 (8.45)
Other	38 (4.5)
Dynamic Contrast enhanced cat	
No, never	473 (56.31)
At least one	302 (35.95)
Yes, in every case	65 (7.74)
DWI sequence	
Yes, in every case	347(41.31)
No, never	285 (33.92)
Evaluation of recurrence of pelvic tumors	519 (61.79)
In case of detection of gynecologic neoplasms	525 (62.50)
In case of staging of gynecologicneoplasms	515 (61.31)
In case of assessment of a pelvic mass	508 (60.48)
In case of evaluation of fibroids	419 (49.88)
In case of identification of congenital anomalies	350 (41.67)
In case of evaluation of Endometriosis	396 (47.14)
In case of assessment of pelvic floor defects	348 (41.43)
Other	27 (3.2)
DWI sequence cat	
No, never	285 (33.93)
At least one	208 (24.76)
Yes, in every case	347 (41.31)
Do you use standardized reporting?	
Yes	281 (46.29)
No	326 (53.71)
NA	233
Are you aware of ESUR guidelines?	
Yes	290 (47.9)
No	315 (52.1)
NA	235
Do you use ESUR guidelines?	
Yes	290 (47.93)
No	315 (52.07)
NA	235

education and teaching. Most of these guidelines are made available on the internet by open-access or can be retrieved from the ESUR homepage (<https://www.esur.org/esur-guidelines/female-pelvis/>).

In our study, the use of oblique axial imaging planes and thin slice thickness was adopted by most respondents

Table 2 Subgroup analysis regarding expertise in gynecological imaging

	Non specialist n = 554	Specialist n = 264	p value
Institution type			
Non-university hospital	294 (53.07)	99 (37.50)	< 0.001*
University hospital	260 (46.93)	165 (62.50)	
NA	0	0	
Gender			
Female	320 (57.76)	167 (63.26)	0.297**
Male	230 (41.52)	96 (36.36)	
Prefer not to say	4 (0.72)	1 (0.38)	
NA	0	0	
Use of T2/T1 sequence covering the whole paraaortic regions			
Yes	319 (70.26)	164 (70.09)	0.961*
No	135 (29.74)	70 (29.91)	
NA	100	30	
Oblique sequence perpendicular to the axis of the uterus or cervix for endometrial or cervical cancer staging			
Yes	363 (81.57)	214 (92.24)	< 0.001*
No	82 (18.43)	18 (7.76)	
NA	109	32	
Slice thickness of axial oblique sequence			
> 4 mm	110 (27.8)	33 (12.5)	< 0.001*
≤ 4 mm	286 (72.2)	189 (87.5)	
NA	158	42	
Do you perform Gadolinium T1WI FS sequence?			
No, never	161 (29.06)	46 (17.42)	0.002*
At least one	289 (52.17)	167 (63.26)	
Yes, in every case	104 (18.77)	51 (19.32)	
Do you perform Dynamic Contrast enhanced/perfusion MRI?			
No, never	347 (62.63)	131 (39.4)	< 0.001*
At least one	170 (30.70)	132 (50.00)	
Yes, in every case	37 (6.7)	28 (10.6)	
Do you perform DWI sequence?			
No, never	218 (39.4)	45 (17.0)	< 0.001*
At least one	123 (22.2)	85 (32.2)	
Yes, in every case	213 (38.4)	134 (50.8)	
Do you use standardized reporting?			
Yes	185 (48.05)	96 (43.24)	0.252*
No	200 (51.95)	126 (56.76)	
NA	169	42	
Do you use ESUR guidelines?			
Yes	149 (38.90)	141 (63.51)	< 0.001*
No	234 (61.10)	81 (36.49)	
NA	171	42	

* χ^2 test; **Fisher

for staging of cervical and endometrial cancer [5]. This is important, these imaging planes facilitate accurate tumor staging and optimal treatment planning [13]. In endometrial cancer depth of myometrial invasion is an important factor for risk stratification and clinical decision making about the need for lymphadenectomy [13–16]. In general, this may be challenging to assess particularly in equivocal cases or in the setting of co-existing benign lesions like leiomyomas and adenomyosis [17]. In cervical

cancer presence of parametrial invasion warrants chemoradiation [18, 19]. The differentiation of subtle parametrial invasion (2b) from full stromal invasion (1b) requires correct angulation to exactly define the outer contour of the cervix and the interface with adjacent parametria [12]. Use of DWI was adopted by more than two thirds of the survey participants. Thus, this study confirms that DWI has become an integral component of female pelvic MR imaging. Furthermore, when the quality is adequate,

Table 3 Subgroup analysis regarding type of institution

	Academic practice n = 434	Non academic practice n = 395	p value
Gender			
Female	278 (64.35)	215 (54.57)	0.010**
Male	152 (35.19)	176 (44.67)	
Prefer not to say	2 (0.46)	3 (0.76)	
NA	2	1	
Specialist in gynecological imaging			
Specialist	165 (38.82)	99 (25.19)	< 0.001*
Non specialist	260 (61.18)	294 (74.81)	
NA	9	2	
Use of T2/T1 sequence covering the whole paraaortic regions			
Yes	248 (69.66)	235 (70.78)	0.748*
No	108 (30.34)	97 (29.22)	
NA	78	63	
Oblique sequence perpendicular to the axis of the uterus or cervix for endometrial or cervical cancer staging			
Yes	309 (87.78)	268 (82.46)	0.051*
No	43 (12.22)	57 (17.54)	
NA	82	70	
What is the slice thickness of your axial or axial oblique sequence?			
> 4 mm	115 (35.49)	106 (35.93)	0.909*
≤ 4 mm	209 (64.51)	189 (64.07)	
NA	110	100	
Do you perform Gadolinium T1WI FS sequence?			
No, never	115 (26.5)	104 (26.3)	0.859*
At least one	235 (54.1)	220 (55.7)	
Yes, in every case	84 (19.4)	71 (18.0)	
Do you perform dynamic contrast enhanced/perfusion MRI?			
No, never	231 (53.2)	231 (58.5)	0.227*
At least one (%)	170 (39.2)	132 (33.4)	
Yes, in every case	33 (7.6)	32 (8.1)	
Do you perform DWI sequence?			
No, never	129 (29.7)	145 (36.7)	0.035*
At least one	106 (24.4)	102 (25.8)	
Yes, in every case	199 (45.9)	148 (37.5)	
Do you use standardized reporting?			
Yes	133 (41.43)	148 (51.75)	0.011*
No	188 (58.57)	138 (48.25)	
NA	113	109	
Do you use ESUR guidelines?			
Yes	174 (54.21)	116 (40.85)	0.001*
No	147 (45.79)	168 (59.15)	
NA	113	111	

* χ^2 test; **Fisher

DWI can substitute contrast enhanced imaging. e.g. in endometrial cancer or serve as an alternative when contrast media should be avoided, e.g. in pregnancy [20, 21]. DWI can also improve visualization of lymph nodes and peritoneal deposits [22]. In contrast, the use of contrast-enhanced imaging varied among radiologists worldwide. While contrast enhanced MRI was performed by 60% of radiologists for evaluation of recurrence, for staging and characterization of sonographically indeterminate masses, there was a variety of the type of technique used.

Contrast-enhanced MRI helps to differentiate tumor from non-neoplastic solid lesions, such as clots or debris within an adnexal mass. The updated ESUR guidelines recommend the use of contrast-enhanced MRI for characterization of indeterminate adnexal masses and also encourage the use of DCE-MRI [7]. Recently, the value of DCE-MRI was highlighted by the findings of a large prospective multicentre study with 1194 patients analysed [10].

Table 4 Subgroup analysis regarding localization

	Other n = 464	Europe n = 376	p value
Establishment type			
Academic	209 (45.93)	225 (60.16)	< 0.001*
Non Academic	246 (54.07)	149 (39.84)	
NA	9	2	
Gender			
Female	259 (57.17)	234 (62.73)	0.183**
Male	192 (42.38)	136 (36.46)	
Prefer not to say	2 (0.44)	3 (0.80)	
NA	11	3	
Specialty			
Specialist	117 (26.06)	147 (39.84)	< 0.001*
Non-specialist	332 (73.94)	222 (60.16)	
NA	15	7	
Do you also use a T2/T1 sequence that covers the whole paraaortic regions?			
Yes	291 (75.19)	192 (63.79)	0.001*
No	96 (24.81)	109 (36.21)	
NA	77	75	
Do you use axial oblique sequence perpendicular to the axis of the uterus or cervix			
Yes	302 (79.47)	275 (92.59)	< 0.001*
No	78 (20.53)	22 (7.41)	
NA	84	79	
What is the slice thickness of your axial or axial oblique sequence?			
> 4 mm	139 (41.00)	82 (29.29)	0.002*
≤ 4 mm	200 (59.00)	198 (70.71)	
NA	125	96	
Do you use standardized reporting?			
Yes	191 (58.05)	90 (32.37)	< 0.001*
No	138 (41.95)	188 (67.63)	
NA	135	99	
Do you use ESUR guidelines?			
Yes	115 (35.06)	175 (63.18)	< 0.001*
No	213 (64.94)	102 (36.82)	
NA	136	99	
Do you perform Gadolinium T1WI FS sequence?			
No, never	129 (27.80)	101 (26.90)	0.942
At least one	249 (53.70)	206 (54.80)	
Yes, in every case	86 (18.50)	69 (18.4)	
Do you perform Dynamic Contrast enhanced/perfusion MRI?			
No, never	282 (60.8)	191 (50.8)	0.015
At least one	149 (32.1)	153 (40.7)	
Yes, in every case	33 (7.1)	32 (8.5)	
Do you perform DWI sequence?			
No, never	182 (39.2)	103 (27.4)	< 0.001*
At least one	118 (25.4)	90 (23.9)	
Yes, in every case	164 (35.3)	183 (48.7)	

* χ^2 test; **Fisher

Our survey showed that in clinical practice DCE-MRI is little used among radiologists interpreting female pelvic MRIs. In detail, it was never performed by 37% of radiologists and was used for adnexal mass characterization by less than 30%. DCE-MRI requires rapid image acquisition and post-processing software

that may not be always available. The role of DCE-MRI is still debated and may be of diagnostic benefit only for selected cases, e.g. in differentiation of borderline tumours and invasive cancers or in the analysis of the contrast enhancement pattern to diagnose rare benign tumours. Future area of research will include change

Table 5 Subgroup analysis regarding Radiology practice

	Resident n = 229	Senior n = 593	p value
Establishment type			
Academic	106 (46.29)	288 (48.57)	0.558*
Non Academic	123 (53.71)	305 (51.43)	
NA	0	0	
Gender			
Female	148 (64.63)	342 (57.67)	0.158**
Male	80 (34.93)	247 (41.65)	
Prefer not to say	1 (0.44)	4 (0.67)	
NA	0	0	
Specialty			
Specialist	29 (12.72)	235 (39.83)	< 0.001*
Non-specialist	199 (87.28)	355 (60.17)	
NA	1	3	
Do you also use a T2/T1 sequence that covers the whole paraaortic regions?			
Yes	134 (72.83)	349 (69.25)	0.363*
No	50 (27.17)	155 (30.75)	
NA	45	89	
Do you use axial oblique sequence perpendicular to the axis of the uterus or cervix			
Yes	145 (80.11)	432 (87.10)	0.023*
No	36 (19.89)	64 (12.90)	
NA	38	97	
What is the slice thickness of your axial or axial oblique sequence?			
> 4 mm	59 (38.56)	162 (34.69)	0.385
< 4 mm	94 (61.44)	305 (65.31)	
NA	76	126	
Do you use standardized reporting?			
Yes	71 (47.33)	210 (45.95)	0.768*
No	79 (52.67)	247 (54.05)	
NA	79	136	
Do you use ESUR guidelines?			
Yes	59 (39.60)	231 (50.66)	0.019*
No	90 (60.40)	225 (49.34)	
NA	80	37	
Do you perform Gadolinium T1WI FS sequence?			
No, never	78 (34.06)	134 (22.60)	0.003*
At least one	110 (48.04)	345 (58.18)	
Yes, in every case	41 (17.90)	114 (19.22)	
Do you perform Dynamic Contrast enhanced/perfusion MRI?			
No, never	141 (61.57)	314 (52.95)	0.048*
At least one	69 (30.13)	233 (39.29)	
Yes, in every case	19 (8.30)	46 (7.76)	
Do you perform DWI sequence?			
No, never	91 (39.74)	176 (29.68)	0.019*
At least one	49 (21.40)	159 (26.81)	
Yes, in every case	89 (38.86)	258 (43.51)	

* χ^2 test **Fisher

in patient management using DCE sequence and the role of non contrast studies. A recent retrospective study including 350 adnexal masses showed that expert radiologists in pelvic MRI were able to correctly diagnose adnexal masses without contrast media with high accuracy [23]. The selective use of gadolinium-based

contrast media may become an increasing important issue due to gadolinium deposition in tissues. e.g. in the brain [24, 25]. However, for now, there is no currently adverse clinical outcome from this finding and adnexal MRI characterisation usually requires a single exam and not multiple follow ups.

In addition, DCE plays a central role in the recently published O-RADS MRI risk stratification system for ovarian/adnexal masses [10, 26].

Finally, the high percentage of almost 50% of standardised reporting in clinical routine may have been biased due to the response rate of 72% for this question. Standardized reporting is rendered both in academic and non-academic but is more commonly performed in non-academic institution. This may also underline the effects of initiatives to globally standardize radiological imaging and reporting [27–29]. In this context emphasis must be put on developing a universally useable and accepted terminology (lexicon) for these reports. For ovarian mass characterisation such a lexicon has recently been published, but further effort is needed [30, 31]. Consistent technique and image quality (e.g. slice thickness and DWI *b* values) is not only of utmost importance to provide standardize imaging technique but also for exploiting this information with techniques of radiomics and machine learning algorithms. This also facilitates comparison of findings across different institutions [32].

Our survey has some limitations. First, as expected with any survey, response rate was low (14%), even though many responses were received. Second, the survey was sent to radiologists associated with the ESR/ESUR (even though many were from outside Europe), who are likely to be familiar with European practice in Radiology and so they may represent a selected group. Owing to the topic of a subspecialized area in Radiology, it is understandable but unavoidable to introduce a bias in comparison with general radiologists who also perform these MRI examinations.

Although this survey shows that radiologists worldwide perform female pelvic MRI studies with a technique and indications that are generally in line with the recommendations of the ESR, barriers and opportunities to improve the knowledge of and adherence to guidelines warrant consideration [33]. Guidelines need to be practical and easily to adopt, they should be clear and not too long and should be easily accessible. Future update of existing guidelines or new guidelines can benefit from this information.

Abbreviations

DCE: Dynamic contrast-enhanced; DCE-MRI: Dynamic contrast-enhanced MRI; DWI: Diffusion weighted imaging; ESR: European society of radiology; ESUR: European society of urogenital radiology; GU: Genitourinary; MRI: Magnetic resonance imaging.

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Authors' contributions

SN, RKH, RF, LD: study design and questionnaire. SN, RF: analysed and interpreted the data. SG: performed the statistical analysis. YL and ES: were a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Availability of data and material

The datasets are not publicly available but would be made available on reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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