Optimized Protocols for Uterus and Ovaries Guided by Recommendations from the European Society of Urogenital Radiology

Oleg Shagalov, Ph.D.; Elisa Roccia, Ph.D.

Siemens Healthineers, Erlangen, Germany

Female pelvic disorders

Female pelvic disorders have a profound impact on women's quality of life and overall health outcomes. Among the most prevalent and clinically significant female pelvic disorders are endometriosis, ovarian cancer, and uterine and cervical cancer.

Endometriosis is a chronic condition characterized by the presence of endometrial-like tissue outside the uterine cavity, which leads to inflammation and scar tissue forming in the pelvic region and sometimes elsewhere in the body. It affects an estimated 10% of women of reproductive age globally. Endometriosis often leads to debilitating pelvic pain, infertility, and a reduced quality of life. Accurate diagnosis remains challenging due to its variable presentation and non-specific symptoms, contributing to diagnostic delays that can span years [1].

Ovarian cancer, one of the leading causes of cancer-related deaths in women, is frequently diagnosed at advanced stages due to the asymptomatic nature of early disease. Timely and precise imaging is essential for differentiating benign from malignant lesions and for guiding surgical and therapeutic interventions [2, 3].

Cervical cancer, which is preventable through vaccination and screening, continues to impact women globally, particularly in regions with limited access to preventive healthcare. Imaging plays a critical role in staging the disease, assessing tumor extent, and evaluating treatment response, all of which are key determinants of patient outcomes [4].

MRI is a key tool for assessing female pelvic disorders: It provides a comprehensive evaluation of the pelvis, helps detect features of malignancy, and enables assessment of extrapelvic involvement. This article reviews current MRI techniques for female pelvic disorders, emphasizing protocol optimization guided by the recommendations of the European Society of Urogenital Radiology (ESUR) [5, 6].

Guidelines from the European Society of Urogenital Radiology

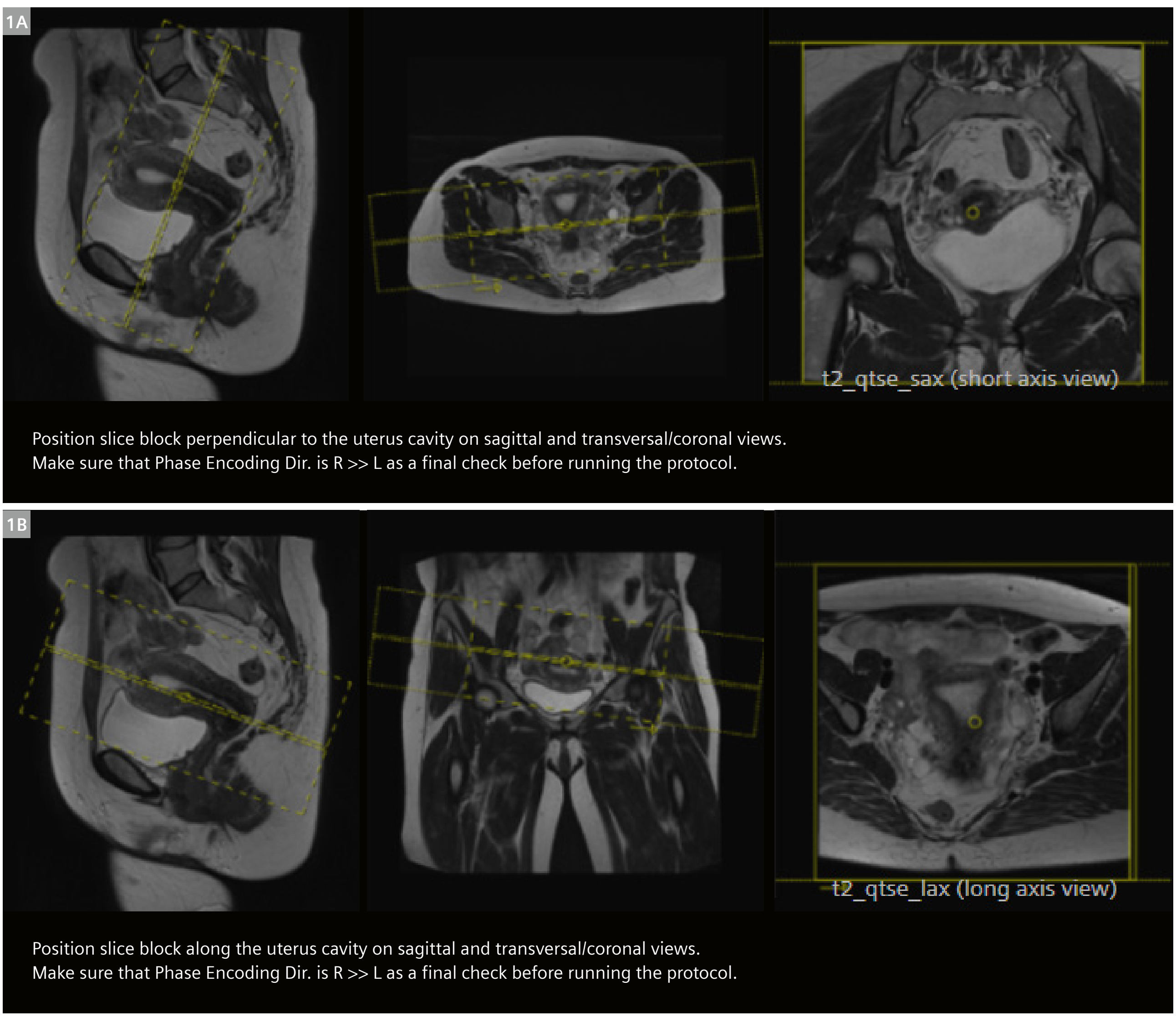
As for many other body regions, specialized professional organizations provide guidance on how to perform pelvic imaging examinations. With the *syngo* MR XB10 software from Siemens Healthineers, we introduce some new pelvic MRI protocols and workflows that were developed according to the ESUR guidelines [5, 6]. As far as gynecological examinations are concerned, there are two new dedicated workflows in the Siemens protocol tree: A uterus workflow and an ovaries workflow. Both workflows include a set of T1W, T2W, DWI, and various protocols for contrast agent usage, where the parameters have been optimized for gynecological imaging, as recommended by the ESUR.

On the one hand, the Siemens tree is intended to provide users with robust protocols with a reasonable scan time that can be used out-of-the-box without further adaptations. On the other hand, whenever possible, protocols are developed in a way that allows them to be easily adapted – to increase resolution or decrease acquisition time, for example.

Uterus workflow

Proper angulation that follows the anatomy of the uterus is important in gynecological imaging to allow for reliable image interpretation. Instead of the transversal and coronal orientations, we decided to use a long-axis (LAX) and a short-axis (SAX) approach in the uterus workflow. In the uterus coordinate system, LAX means that the slices are positioned along the uterus body, whereas SAX means that the slices are positioned perpendicular to the uterus body. To make the examinations more reproducible, we introduced guidance images for all protocols utilizing these new orientations (Fig. 1).

After the conventional three-plane localizer, the uterus workflow (Fig. 2A) continues with a focused sagittal T2W protocol, which also helps position LAX and SAX protocols more precisely. The next protocol is T2W SAX, which, together with the sagittal protocol, is mandatory according to the ESUR guidelines for endometrial cancer staging. The T2W LAX protocol is provided as an option in the same protocol folder. The DWI series should mirror the T2W SAX protocol positioning, so a copy reference with the "slices" option is used. The contrast-enhanced series are represented by a dynamic protocol with a time resolution of 10 seconds and a single-phase high-resolution post-contrast protocol. The ESUR also recommends T2W and DWI protocols with a bigger coverage for lymph-node evaluation. These are available in a separate library folder [5].



1 **(1A)** Protocol guidance for short-axis (SAX) positioning of the uterus. **(1B)** Protocol guidance for long-axis (LAX) positioning of the uterus.

Ovaries workflow

The ovaries workflow (Fig. 2B) also starts with a conventional three-plane localizer and a sagittal T2W protocol. As there is no specific recommendation on the orientation for the remainder of the protocols, we use transversal by default, but this can be changed by the user. A T2W and a T1W Dixon series follow, the latter providing in-phase and opposed-phase images for microscopic fat definition. The DWI utilizes a higher b-value (1000 s/mm^2) compared to the uterus DWI protocol in order to enable higher contrast of lesions [7]. The dynamic and single-phase high-resolution post-contrast series are the same as in the uterus workflow.

Deep Resolve

All T2W and DWI protocols from both the uterus and ovaries workflows are also provided in their accelerated version using the AI-accelerated technique Deep Resolve[1] and are stored in the Deep Resolve library. In a nutshell, Deep Resolve allows to reduce scan times while maintaining, or even improving, image quality.

Further protocol details

The protocols described above are also provided without a specific orientation. These can be rotated as required, with guidance on how to select the appropriate phase-encoding direction.

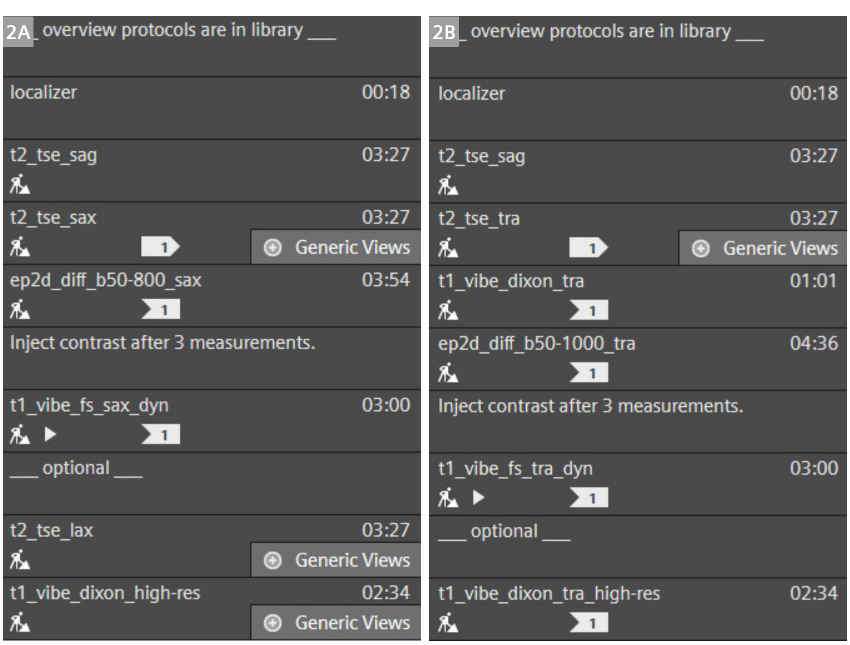
In software version *syngo* MR XB10, we also introduced new large field of view protocols (overview protocols) for the whole pelvis with different contrasts, fat suppression techniques, and orientations. These are available in a separate library folder. Most of the overview protocols have a slice thickness of 4 mm, whereas the focus protocols have 3 mm slices for both 1.5T and 3T.

T2W protocols use a high parallel imaging factor of 4, even in the versions without deep-learning acceleration. The high parallel imaging factor, combined with the high number of averages (4 or even 5 for certain systems) helps to significantly reduce motion artifacts, which are typically induced by bowel movement. Whenever possible, the phase resolution is kept at (or close to) 100%. Although

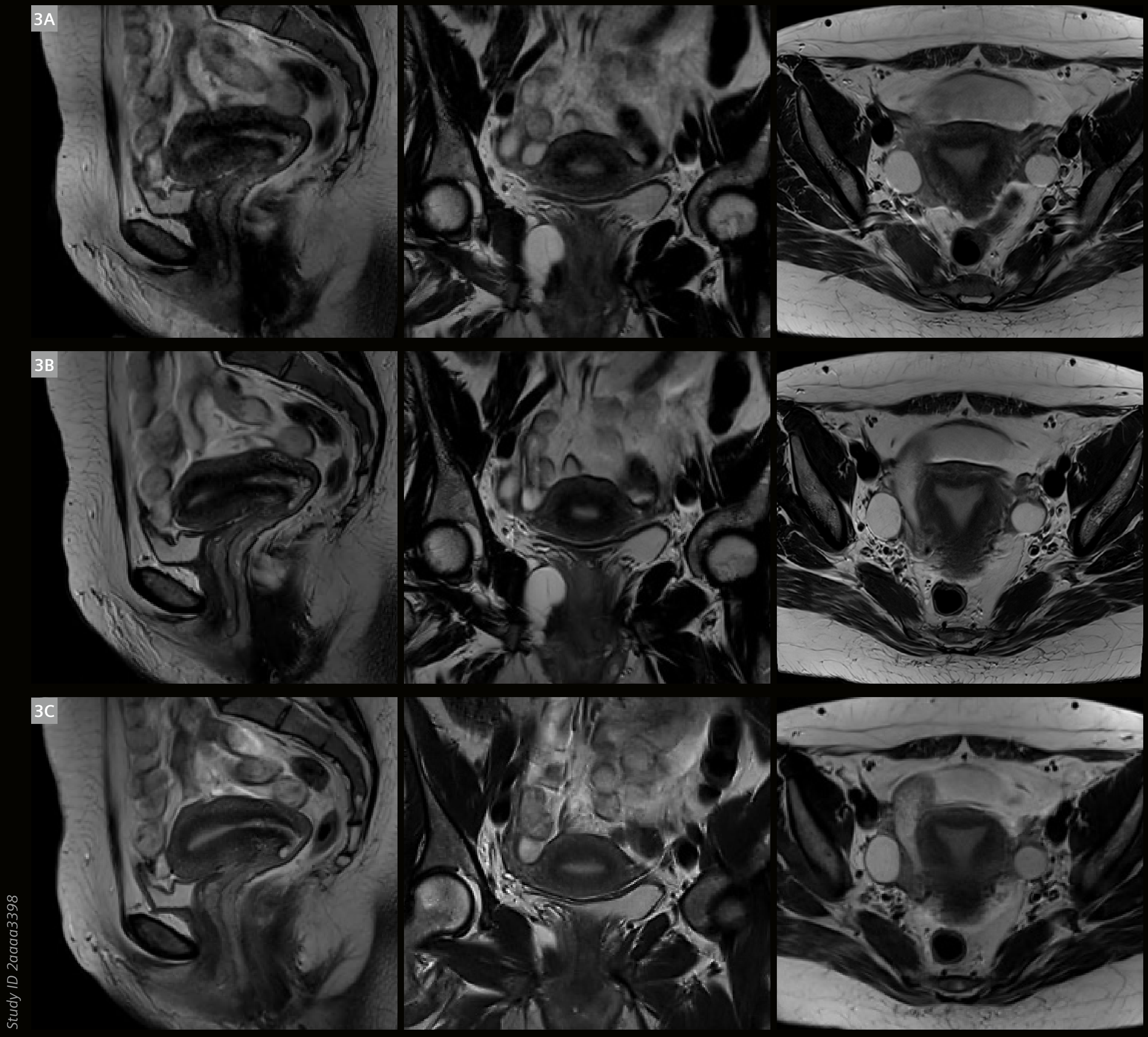
[1] *Deep Resolve requires a dedicated software license.*

	Uterus	Uterus with Deep Resolve	Ovaries	Ovaries with Deep Resolve
MAGNETOM Sola (1.5T)	14:06 min	10:46 min	15:49 min	12:10 min
MAGNETOM Vida (3T)	13:53 min	9:07 min	15:23 min	11:09 min

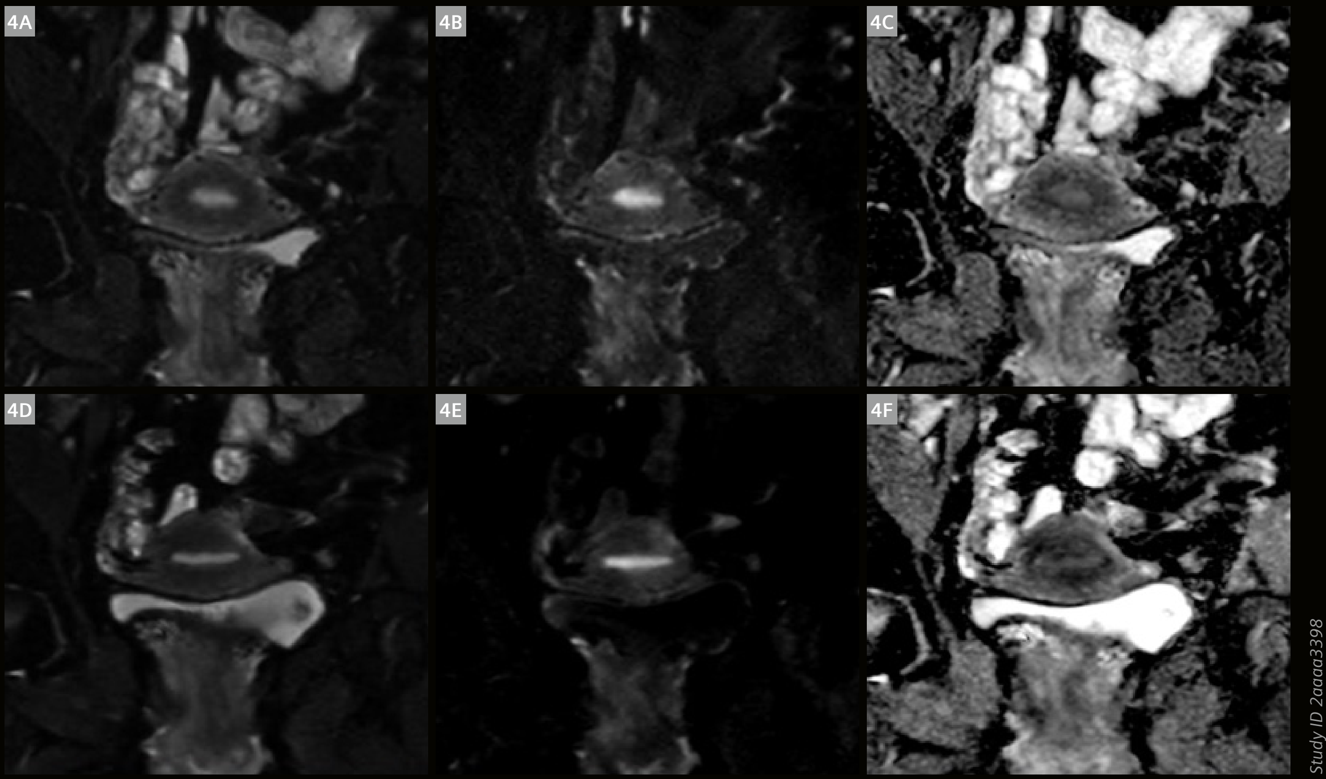
Table 1: Acquisition time reduction enabled by Deep Resolve for the uterus and ovaries protocols at both 1.5T and 3T.



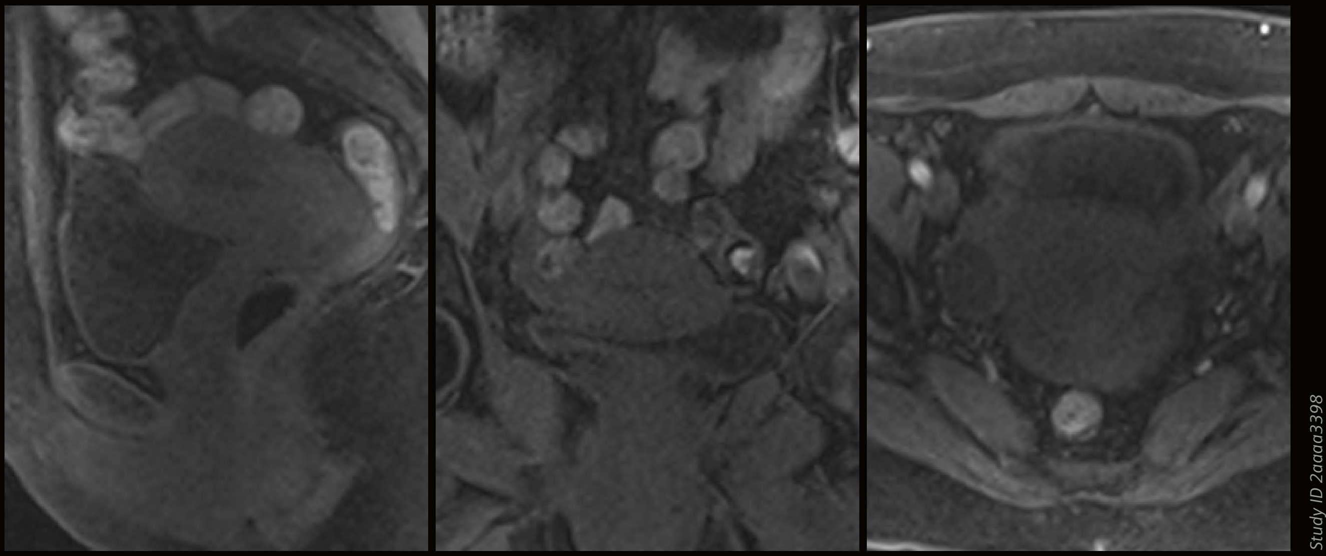
2 **(2A)** Overview of the uterus workflow. **(2B)** Overview of the ovaries workflow.



3 T2W imaging of the uterus body (sagittal, short axis, and long axis): conventional TSE, 3:36 min **(3A)**, TSE with Deep Resolve, 1:54 min **(3B)**, TSE BLADE, 3:29 min **(3C)**.



4 DWI of the uterus body/ovaries (short-axis view, **(4A)** b50, **(4B)** b1000, **(4C)** ADC): conventional echo planar imaging (EPI), 4:06 min **(4A–4C)**; EPI with Deep Resolve, 3:06 min **(4D–4F)**.



5 T1W imaging for dynamic contrast enhancement of the uterus body and ovaries (sagittal, short axis, and long axis), 10 seconds per phase.

using reduced phase resolution would help increase the signal-to-noise ratio (SNR) and reduce scan times simultaneously, we found that this has a significant negative impact on image sharpness. Since pelvic examinations often suffer from artifacts due to bowel motion, focus T2W protocols are also offered using the BLADE technique, which is more robust towards motion.

All **DWI** protocols use a 3D diagonal scheme to increase image sharpness, since there is no indication of anisotropic diffusion in the pelvic region, except in the prostate. For the same reason, when scan time allows, the phase resolution is kept at 100%, and partial Fourier is either off or set to the minimum. Deep Resolve protocols should always be used with maximum phase oversampling to avoid aliasing induced by the SENSE-based reconstruction. To compensate for the echo time increase of the increased phase oversampling, a parallel imaging factor of 3 is used.

Protocols for **dynamic** contrast enhancement must have a time resolution below 10 seconds while preserving a reasonable spatial resolution. The main change compared to previous protocol versions is a new CAIPI scheme using only 1 in the phase-encoding direction, but 4 in the slice direction with a shift of 2. This approach helps avoid aliasing in the phase-encoding direction, which usually appears in the middle of the image in correspondence with the region of interest. To reduce motion and third-arm artifacts, the flip angle was slightly decreased, and the receiver bandwidth set to the maximum. To improve SNR, reduced by fat suppression and by the high temporal and spatial resolution, prescan normalize was switched off. Even though this might result in imperfect fat suppression in the periphery of the image, it does not affect the region of interest.

Conclusion

Accurate and timely diagnosis of female pelvic disorders is essential for improving patient outcomes and quality of life. MRI plays a pivotal role in this effort, offering detailed anatomical and functional information that supports diagnosis, staging, and treatment planning. By aligning with ESUR recommendations, the new uterus and ovaries workflows introduced in the *syngo* MR XB10 software provide standardized, high-quality imaging protocols tailored to gynecological needs. In addition, Deep Resolve can be applied to further accelerate scan times while maintaining high image quality – enhancing patient comfort and workflow efficiency. With these advancements, MRI continues to evolve as a key pillar in the evaluation and management of female pelvic health.

References

1 World Health Organization. Endometriosis [Internet]. Geneva, Switzerland: World Health Organization; 2023 March 24 [accessed 2025 July 07]. Available from: https://www.who.int/news-room/fact-sheets/detail/endometriosis
2 Doubeni CA, Doubeni AR, Myers AE. Diagnosis and Management of Ovarian Cancer. Am Fam Physician. 2016;93(11):937–44.
3 Engbersen MP, Van Driel W, Lambregts D, Lahaye M. The role of CT, PET-CT, and MRI in ovarian cancer. Br J Radiol. 2021;94(1125):20210117.
4 Mansoori B, Khatri G, Rivera-Colón G, Albuquerque K, Lea J, Pinho DF. Multimodality Imaging of Uterine Cervical Malignancies. AJR Am J Roentgenol. 2020;215(2):292–304.
5 Nougaret S, Horta M, Sala E, Lakhman Y, Thomassin-Naggara I, Kido A, et al. Endometrial Cancer MRI staging: Updated Guidelines of the European Society of Urogenital Radiology. Eur Radiol. 2019;29(2):792–805
6 Thomassin-Naggara I, Dolciami M, Chamie LP, Guerra A, Bharwani N, Freeman S, et al. ESUR consensus MRI for endometriosis: indications, reporting, and classifications. Eur Radiol. 2025. Epub ahead of print.
7 Reinhold C, Rockall A, Sadowski EA, Siegelman ES, Maturen KE, Vargas HA, et al. Ovarian-Adnexal Reporting Lexicon for MRI: A White Paper of the ACR Ovarian-Adnexal Reporting and Data Systems MRI Committee. J Am Coll Radiol. 2021;18(5):713–729.

Contact

Elisa Roccia, Ph.D.
Global Clinical Marketing Manager Oncology
SHS DI MR M&S CSM
Park View, Watchmoor Park
Camberley
Surrey GU15 3YL
United Kingdom
elisa.roccia@siemens-healthineers.com

Oleg Shagalov, Ph.D.
Senior Applications Developer
SHS DI MR R&D SWI AFT APPL
Allee am Roethelheimpark 2
91052 Erlangen
Germany
oleg.shagalov@siemens-healthineers.com