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Optimization of Pelvic MRI for Suspected Malignant Ovarian Cystoma Through Intraluminal Ultrasound Gel Administration and the Addition of an Axial T2-FFE Sequence at Gambiran Public Hospital

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ABSTRACT

Suspected malignant cystoma ovarii poses diagnostic challenges in pelvic MRI due to collapsed inferior pelvic boundaries (vagina, rectum, uterus), hindering lesion infiltration assessment. Standard MRI protocols are suboptimal for detecting hemorrhage within lesions, necessitating technique modifications to enhance diagnostic accuracy in resource-limited settings like RSUD Gambiran, Kediri City. Objective: To describe the role of intraluminal ultrasonic gel administration (pervaginal and perrectal) and addition of axial T2-FFE sequence in optimizing pelvic MRI protocols for suspected malignant cystoma ovarii cases. Methods: Qualitative case study on one reproductive-age female patient diagnosed with cystoma ovarii. Key informants included performing radiographer, expert radiologist reader, and referring physician. Data collected via procedure observation, in-depth interviews, and image documentation. Narrative interactive analysis applied. Protocol: MRI safety screening, renal function tests (BUN/creatinine), 50 cc ultrasonic gel insertion pervaginally/perrectally, sequences T2W TSE/SPAIR, T1W TSE/SPIR, DWI, plus T2-FFE axial. Results: Ultrasonic gel distended vaginal/rectal lumens, clearly delineating anatomical boundaries with uterus (rectouterine pouch, rectovaginal septum), facilitating infiltration evaluation without plane obliteration. Axial T2-FFE revealed no hemorrhagic components in the lesion, aiding cyst content characterization. Conclusion: Protocol modifications using ultrasonic gel and T2-FFE axial enhance pelvic MRI image quality, supporting accurate diagnosis of suspected malignant cystoma ovarii through superior organ boundary visualization and blood product detection. Recommended for complex adnexal cases in limited facilities, despite transient patient discomfort.

Keywords: *Pelvic MRI, cystoma ovarii, ultrasonic gel, T2-FFE, suspected malignancy.*

INTRODUCTION

Magnetic Resonance Imaging (MRI) represents a premier diagnostic modality capable of generating multiplanar anatomical cross-sections with superior soft tissue contrast differentiation compared to computed tomography (CT). This capability makes MRI particularly valuable for detecting soft tissue lesions, while parameter adjustments enable optimized sequences for specific pathologies.

(Grover et al., 2015). MRI Pelvic indications encompass congenital urogenital anomalies, reproductive system disorders, endometriosis diagnosis, benign uterine tumor assessment, and infertility evaluation support. (Westbrook, Roth and Talbot, 2019). Ovarian cysts manifest as abnormal sac-like growths typically containing fluid near the ovaries, with etiologies spanning physiological follicular cysts to potentially malignant lesions. Epidemiologically, they predominantly affect women of reproductive age. (Kemal and Et.al, 2022).

Standard pelvic MRI protocols employ transversal sequences such as T2 Fast Spin Echo (FSE), T2 fat saturation, T1 FSE, and T1 fat saturation; coronal T2 Turbo Inversion Recovery Magnitude (TRIM/STIR) or T2 FSE with fat saturation; sagittal T2 FSE; and post-contrast axial/coronal T1 as needed (Möller and Reif, 2019).At RSUD Gambiran Kediri Radiology Installation, cystoma ovarii cases utilize transversal sequences T2W TSE breath-hold (BH), T2W SPAIR BH, T1W TSE, T1W SPIR, DWI BH, T2-FFE BH; sagittal T2W SAG BH; coronal T2W COR BH, T2W SPAIR COR; with post-contrast T1W TSE Gadolinium across planes. Procedures incorporate pre-examination vaginal ultrasonic gel and added transversal T2-FFE sequence.This study investigates the role of intraluminal ultrasonic gel and transversal T2-FFE addition in optimizing pelvic MRI for suspected malignant cystoma ovarii, addressing collapsed pelvic boundaries that obscure lesion infiltration assessment and limited hemorrhage detection in standard protocols.

METHODS

This research employed a qualitative approach utilizing a case study design. Research subjects comprised one patient undergoing pelvic MRI examination with cystoma ovarii diagnosis, alongside key informants consisting of one performing radiographer, one specialist radiologist serving as expert image reader, and one referring physician for cystoma ovarii cases with malignancy suspicion.

Research instruments included observation guidelines, in-depth interview guides targeting the radiographer, specialist radiologist, and referring physician, plus documentation. Data analysis utilized interactive model analysis, presented through narrative description to support conclusion formulation. Equipment preparation for pelvic MRI examination included MRI scanner, abdomen coil, fixing belt, ear plugs, blanket, and printer. Material preparation comprised ultrasonic gel, 50cc and 10cc syringes, underpad, handscoops, gadolinium contrast, and saline solution.Patient preparation followed standard protocols: no special dietary requirements, but renal function verification (BUN, serum creatinine) required if gadolinium contrast planned. Pre-examination MRI safety screening conducted via patient questionnaire. Ferromagnetic objects prohibited in MRI room. Patient educated to remain still to prevent motion artifacts. Prior to acquisition, 50cc ultrasonic gel administered intraluminally into vagina for lumen distension.

Patient positioning: Supine, feet-first into gantry, mid-sagittal plane aligned with longitudinal indicator. Arms positioned above head to minimize artifacts. Abdomen coil centered at pelvis midline, secured with fixing belt. Earplugs/headset provided for noise reduction, emergency buzzer accessible, blanket for thermal comfort (Westbrook,2022). Examination protocol: Patient data loaded from hospital information system to MRI workstation. Survey scan generated transversal, coronal, sagittal planes. Protocol sequences: Transversal - T2W TSE BH, T2W SPAIR BH, T1W TSE, T1W SPIR, DWI BH, T2-FFE BH; Coronal - T2W COR BH, T2W SPAIR BH; Sagittal - T2W SAG BH (Möller and Reif, 2019).

RESULTS

This study used a qualitative approach with a case study design. The research subject was one patient who underwent a pelvic MRI examination with a diagnosis of ovarian cystoma, while the informants consisted of one radiographer, one radiologist as the expert reader, and one referring physician in the case of ovarian cystoma with suspected malignancy. Data collection instruments included an observation guideline, an in-depth interview guideline for the radiographer, the radiologist, and the referring physician, as well as documentation. Data analysis was carried out using an interactive analysis model, and the results were then described in narrative form to support the drawing of conclusions..

The preparation of equipment and materials for a pelvic MRI examination using ultrasonic gel in a case of ovarian cystoma with suspected malignancy at the Radiology Installation of RSUD Gambiran Kediri includes the MRI unit, abdominal coil, fixing belt, earplugs, blanket, printer, as well as computer and workstation, which is in accordance with the theory according to (Westbrook, 2022). The difference lies in the preparation of materials, namely ultrasonic gel, a 50 cc syringe, a 10 cc syringe, underpad, hand gloves, gadolinium contrast, and saline. Patient preparation for pelvic MRI in cases of ovarian cystoma with suspected malignancy at the Radiology Installation of RSUD Gambiran Kediri is consistent with the theory (Möller & Reif, 2019).

In this pelvic MRI examination, no special preparation is required. However, prior to the procedure, the patient is asked to bring the results of kidney function tests, namely Blood Urea Nitrogen (BUN) and serum creatinine. Before the examination begins, a safety screening is carried out by asking questions regarding the patient's readiness and suitability for MRI. While in the MRI room, the patient is not allowed to wear or carry objects containing ferromagnetic materials, such as jewelry, ATM cards, mobile phones, keys, and is asked to remove dentures and other metal objects. The patient is also educated to remain calm and minimize movement during the examination, as motion can reduce image quality. Before the acquisition process begins, the patient is given ultrasonic gel inserted intraluminally into the vagina in a volume of 50 cc.

The patient positioning for a pelvic MRI examination of ovarian cystoma with suspected malignancy at the Radiology Installation of RSUD Gambiran is as follows: the patient is placed in the supine position with the feet entering the gantry first (feet first). The patient's position is adjusted so that the Mid Sagittal Plane (MSP) is precisely aligned with the longitudinal indicator light. The hands are placed above the head to avoid interference with the area being examined and to prevent artifacts. The abdominal coil is positioned over the abdominal area with its central point aligned at the midpoint of the pelvis. A fixing belt is applied to prevent the coil from shifting. Earplugs and a headset are placed to reduce the noise generated during the examination. An emergency buzzer is given to the patient so they can signal if they feel uncomfortable during the procedure. A blanket is provided to keep the patient warm and prevent them from feeling cold during the examination. This procedure is consistent with the theoretical principles described by (Westbrook, 2022).

After the patient's position has been properly arranged, the patient's data are entered from the hospital SIM system into the MRI workstation. Once rechecked and confirmed to be correct, the next step is to select the protocol for the pelvic MRI examination. The examination begins with the acquisition of a survey scan. In this survey, three patient planes are obtained, resulting in survey images in the transverse, coronal, and sagittal orientations. Subsequently, the examination is performed according to the stored protocol for pelvic MRI, which includes the following sequences : T2W_TSE_BH, T2W_SPAIR_BH, T1W_TSE, T1W_SPIR, DWI_BB_BH, T2_FFE_BH for transverse slices , T2W_COR_BH, T2_SPAIR_BH for coronal slices, T2W_Sag_BH for sagittal slices. According to (Möller & Reif, 2019) the sequences used for pelvic MRI examination are as follows: in the transverse plane, T2_FSE (Fast Spin Echo), T2 Fat Saturation, T1_FSE, and T1 Fat Saturation are used. For the coronal plane, the sequences used are T2_TRIM (Turbo Inversion Recovery Magnitude) / STIR (Short Tau Inversion Recovery) or T2_FSE and T2 Fat Saturation. For the sagittal plane, the T2_FSE sequence is used. After contrast administration, axial T1 and coronal T1 sequences are performed if necessary. The function of each sequence will be explained in Table 1.

Table 1. The function of each sequence will be explained (Westbrook, 2022)

Sequence	Function
T1W_TSE	To assess whether there are any anatomical structural abnormalities in the pelvis.
T2W_TSE	To evaluate the medical condition in the pelvic area.
T1_ SPIR	To determine whether the suspected abnormality has signal intensity consistent with blood or not.
T2_SPAIR	To detect pathologies such as edema (swelling) and inflammation that are often masked by the bright signal from fat on T2W-TSE weighted images.
DWI_BB	To identify suspected abnormalities such as masses.
T2W_FFE	To visualize and detect conditions related to fluid and soft tissues in the
T1W_TSE+Gadolinium	body, such as hemorrhage and lesions.
	To enhance visual contrast and detect various abnormalities in tissues that are difficult to see on standard MRI imaging.

In a pelvic MRI examination using ultrasonic gel, the anatomical boundary between the rectum and the uterine wall appears clearer, as do the boundaries between the vagina and the uterine wall, and between the vagina and the rectal wall. When compared with images obtained without ultrasonic gel, the delineation of the vagina, rectum, and uterine wall appears less distinct, accompanied by images of the vagina and rectum that are not optimally distended. In addition, the use of the T2-FFE sequence provides additional information indicating that the lesion seen on the images does not show any blood component.

DISCUSSION

Reasons for Using Ultrasonic Gel in Pelvic MRI Examination in a Case of Ovarian Cystoma with Suspected Malignancy at the Radiology Installation of RSUD Gambiran Kediri. Ovarian cysts are abnormal tissue growths that form fluid-filled sacs around the ovary. Ovarian cysts have various etiologies, ranging from physiological (such as follicular cyst of the ovary) to ovarian malignancy, and they occur more frequently in women of reproductive age (Suryoadji et al., 2022). The purpose of using ultrasound gel in pelvic MRI examination is to serve as a contrast medium that differentiates the vaginal lumen, rectal lumen, and pathological lesions, more specifically to visualize the boundaries between normal tissue and pathological tissue.

In addition, the reason for using ultrasonic gel in pelvic MRI examination in a case of ovarian cystoma with suspected malignancy is that, when the vagina and rectum are collapsed, the role of ultrasound gel is to distend the vagina and rectum, thereby facilitating the evaluation of deep infiltrating endometriosis (DIE). Ultrasonic gel has no significant side effects for patients; however, some patients may feel slightly uncomfortable (Sepra et al., 2019).

The reason for using ultrasonic gel in pelvic MRI examination at the Radiology Installation of RSUD Gambiran is to determine whether there is infiltration or extension of the lesion into the vagina and rectum in cases of ovarian cystoma with suspected malignancy, because the administration of ultrasound gel can differentiate between the vaginal lumen, rectal lumen, and pathological lesions—in other words, the use of ultrasound gel is intended to visualize the boundaries between organs, as well as between normal and pathological tissues. Ultrasound gel should ideally be administered into both the vagina and the rectum; however, for patients who are still virgins, the gel is given only through the rectum.

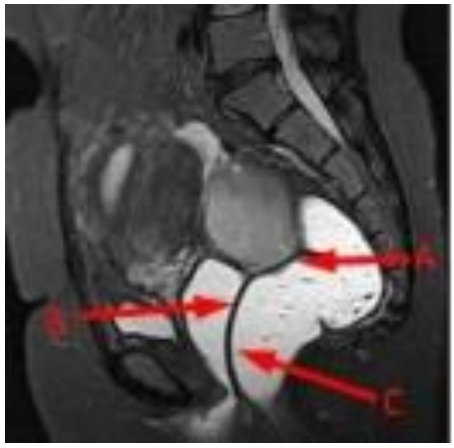

Figure 1. Pelvic MRI image with ultrasound gel (Sepra et al., 2019)
Caption: A.The boundary between the rectum and the uterine wall is clearly visible ; B.The boundary between the vagina and the uterine wall is clearly visible ; C.The boundary between the vagina and the rectal wall is clearly visible.

In Figure 1, it can be seen that in the area marked by arrow A, the delineation between the rectum and the posterior surface of the uterus appears sharp, with the rectouterine pouch (pouch of Douglas) still identifiable, so there is no evidence of direct rectal involvement of the posterior uterine wall in this slice. In the area of arrow B, the anatomical boundary between the upper vagina (including the fornices) and the cervical/uterine segment is clearly visible, without obliteration of the separating plane that would suggest pathological infiltration or adhesion in the available slice. In the area of arrow C, the rectovaginal plane (rectovaginal septum) appears intact, with clear separation between the posterior vaginal wall and the anterior rectal wall, so there are no signs of invasion into the rectovaginal space or direct rectal involvement in this slice.

Furthermore, the use of ultrasonic gel in pelvic MRI examination also serves to distend the vaginal and rectal lumen; if the vagina and rectum are collapsed, this makes evaluation easier. According to (Möller & Reif, 2019) pelvic MRI examination does not require ultrasonic gel and can be performed using a standard pelvic MRI protocol.

In the author's opinion, the administration of ultrasound gel for pelvic MRI examination in cases of ovarian cystoma with suspected malignancy at RSUD Gambiran Kediri is very helpful in establishing the diagnosis, as it produces optimal image quality. However, the drawback is that patients may feel uncomfortable with the ultrasound gel inserted into the vagina and rectum..

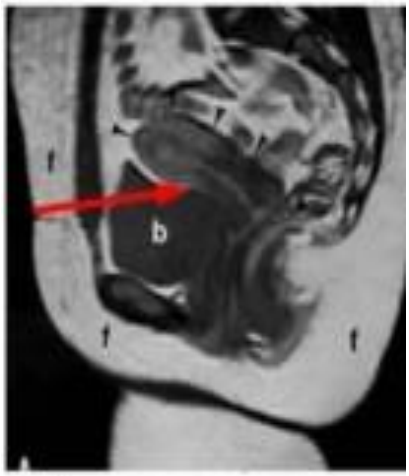

Figure 2. Pelvic MRI image without the use of ultrasonic gel (Sepra et al., 2019)
Caption: The arrows indicate that the boundaries between the vagina, rectum, and uterine wall are less clear, and the vagina and rectum appear incompletely distended.

Reasons for Adding the T2-FFE Transverse Sequence in a Case of Ovarian Cystoma with Suspected Malignancy at RSUD Gambiran Kediri. According to (Yoneyama, 2013) T2-FFE (T2-Fast Field Echo) is a fast T_2-weighted MRI sequence. This sequence produces images with T_2 characteristics (related to proton relaxation) in a short time and can be used to generate "black blood" (indicating blood flow) in 3D images efficiently. Although it has advantages, T2-FFE can be sensitive to motion and has a lower signal-to-noise ratio compared to other sequences, so it often requires optimization for routine clinical use.

According to (Halankar, 2017) the T2-FFE characteristics in ovarian cystoma are related to strong fluid signal. In simple cysts (for example, simple functional cysts), the fluid within the cyst appears very bright or hyperintense on T2-FFE. If the cyst contains other materials, such as blood products or fat, the signal may differ. In cases of endometrioma or cysts containing old (brown) blood, a feature known as T2 shading is often seen, meaning the lesion appears bright on T1 but darker on T2 (with dark spots within the cyst). In dermoid cysts or cysts containing fat, hair, and other solid materials, T2-FFE will show strong signal, but this signal will disappear when a fat-suppression sequence is used. T2-weighted sequences are very helpful in differentiating the fluid-filled portion of the cyst from solid components within it. Solid components that show abnormally increased signal on T2 may suggest malignancy, although this must be evaluated together with other sequences and post-contrast imaging. The function of T2-FFE in diagnosis is to help determine the type of cyst based on signal characteristics, for example by differentiating functional cysts, endometriomas, and dermoid cysts. Together with other MRI sequences, T2-FFE provides the necessary information for assessment systems such as O-RADS MRI (Ovarian-Adnexal Reporting and Data System Magnetic Resonance Imaging), which helps classify the risk of malignancy in ovarian tumors (Mitchell, 2021).

According to the theory of (Möller & Reif, 2019) pelvic MRI does not require the addition of a transverse T2-FFE sequence. In contrast, the pelvic MRI protocol for cases of ovarian cystoma with suspected malignancy at RSUD Gambiran Kediri includes an additional transverse T2-FFE sequence, referring to findings from research studies (Mitchell, 2021), (Halankar, 2017), and (Yoneyama, 2013). In the author's opinion, adding the transverse T2-FFE sequence in cases of ovarian cystoma with suspected malignancy is very helpful in determining the type of cyst based on signal characteristics, and also greatly assists in evaluating hemorrhage within the mass or lesion. This is demonstrated in the following image:

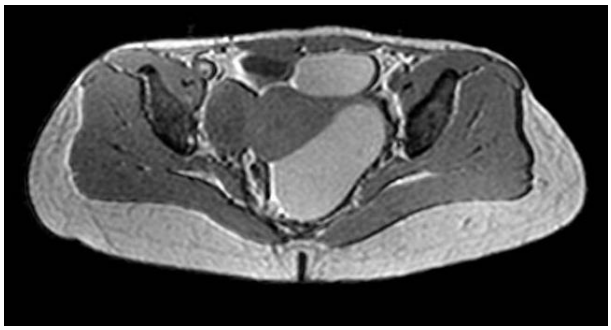

Figure 3. MRI image of the T2-FFE sequence

Caption: From the image above, it can be seen that the lesion does not contain blood.

T2-FFE (T2 Fast Field Echo) sequence in pelvic MRI generally belongs to the gradient-echo group of sequences that emphasize T2*/susceptibility contrast, making it sensitive to magnetic field inhomogeneities caused by blood products, calcifications, or iron deposition. Due to these characteristics, T2*-weighted gradient-echo sequences are often used to identify the presence of hemorrhagic components, particularly paramagnetic blood products, which may appear as hypointense areas accompanied by a blooming effect, including within lesions or tumor masses.

In adnexal masses, information about the presence or absence of a hemorrhagic component is important for characterizing the cyst contents, differentiating possible hemorrhagic cysts/endometriomas from other lesions, and assessing internal heterogeneity. The T2-FFE/T2* sequence can complement conventional T1/T2 and DWI because it is more sensitive to low signal

caused by certain blood products that may not be as clearly visible on TSE (spin echo) sequences, which use refocusing pulses and tend to reduce susceptibility effects.

CONCLUSION

The modified pelvic MRI protocol incorporating intraluminal ultrasonic gel administration and the addition of a transverse T2-FFE sequence proved highly effective for ovarian cystoma cases with suspected malignancy at RSUD Gambiran Kediri. This approach significantly enhanced image quality by clearly delineating anatomical boundaries between inferior pelvic structures (vagina, rectum, uterus), distending collapsed lumens, and facilitating accurate assessment of lesion infiltration without obliteration of separating planes. The T2-FFE sequence provided valuable additional insights for cyst content characterization, particularly in detecting or ruling out hemorrhagic components within adnexal lesions, effectively complementing standard T1/T2 and DWI protocols. This method supports more precise diagnosis, including O-RADS MRI risk stratification for ovarian tumors, despite temporary patient discomfort. Recommendation: This modified technique is recommended for complex adnexal cases in resource-limited facilities, with adaptations for virgin patients (rectal gel only) and patient education to minimize discomfort.

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