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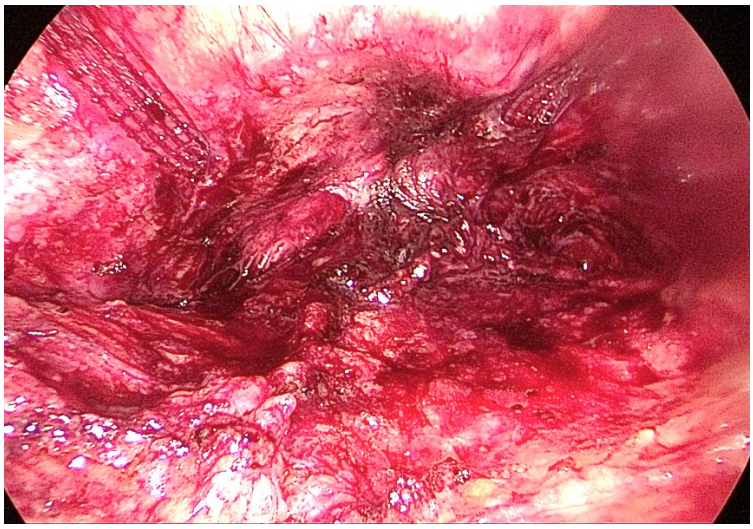

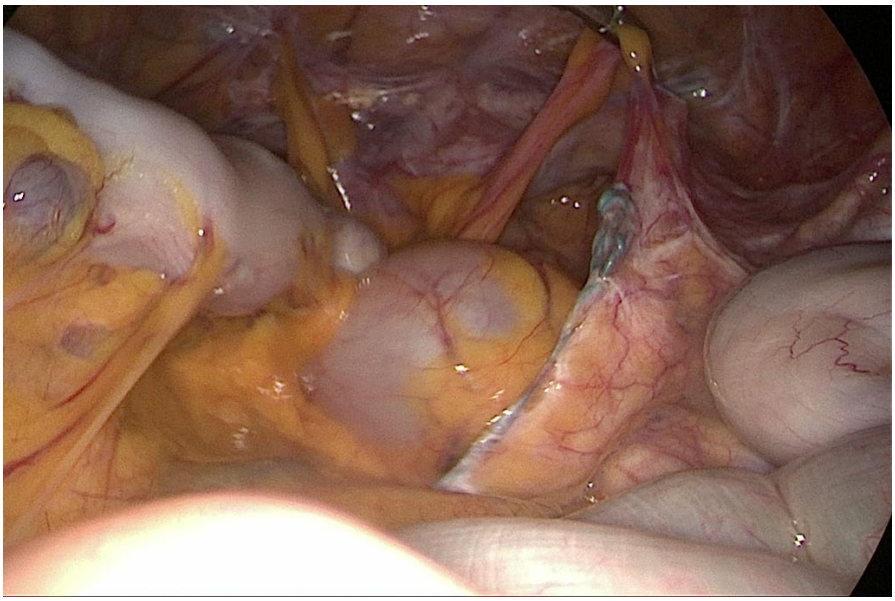

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Impact of Social Media on Endometriosis treatment

Dear all,

Social media platforms have a significant influence on medical popular knowledge and the rejection of hormone treatment for endometriosis is an increasing issue for physicians meanwhile. As Gynecologists we have to be aware of the power of social media and we have to know what happens outside our clinics and ambulatories. Endometriosis is a disease mainly influencing young women's life; therefore, it plays especially in this group a major role. I have investigated social media and found informative content, professional groups offering very good support and information. But nevertheless, there is a huge amount of content on s.m. which is misleading and trying to make business with the disease.

Users often share personal experiences, articles, and opinions about treatments. Misinformation or anecdotal evidence can spread rapidly, influencing people's perceptions and decisions especially about hormone therapy for endometriosis.

Social media groups and forums provide a space for people with endometriosis to share their experiences and support each other. Positive or negative experiences with hormone therapy shared within these communities can strongly influence others' attitudes toward such treatments. If influential users or a significant number of community members express dissatisfaction or adverse effects from hormone therapy, it can lead to a broader rejection of this treatment approach regardless research evidence. Social media exposes users to a wide range of treatment options, including alternative and complementary therapies. This increased awareness can lead some individuals to seek non-hormonal treatments, influenced by the testimonials and experiences shared by others on these platforms. SM is a powerful tool for advocacy. Activist groups and influencers may campaign against hormone therapies, emphasizing potential side effects, risks, or promoting a natural or holistic approach to managing endometriosis. These campaigns can shape public opinion and influence individual treatment choices. Negative experiences and adverse effects of hormone treatments tend to be more prominently shared and discussed on social media compared to positive outcomes. This amplification of negative stories can create a biased perception, leading to increased skepticism and rejection of hormone therapies. This can fuel mistrust in conventional medical treatments and institutions. This mistrust can be exacerbated by stories of misdiagnosis, inadequate care, or dismissive attitudes from healthcare professionals, leading individuals to reject hormone therapies in favor of alternatives perceived as safer or more holistic.

Health influencers and celebrities often share their health journeys on social media. Their endorsements or criticisms of certain treatments can heavily influence public opinion. If a popular figure rejects hormone therapy for endometriosis, their followers may be more likely to do the same. Overall, social media platforms significantly shape public perception and individual decisions regarding hormone therapy for endometriosis. They provide both opportunities for shared knowledge and challenges in terms of spreading misinformation and amplifying negative experiences.

The rejection or reduced use of hormone therapy for endometriosis can have several significant impacts on the treatment of the condition and result in: Increased Pain and Symptoms, Limited Treatment Options, Surgical Interventions, reduce Quality of Life.

Healthcare providers might need to invest more in patient education and support services to help patients manage their symptoms through non-hormonal means. This includes providing information about pain management strategies, mental health support, and connecting patients with support groups. Overall, the rejection of hormone therapy for endometriosis poses challenges but also

opportunities for advancing treatment and patient care through the exploration of new therapies and comprehensive management approaches.

How can Physicians combat misleading information regarding hormone treatment for endometriosis?

First of all, patient education is a task. Provide thorough and clear information during consultations. Explaining the benefits, risks, and potential side effects of hormone therapy helps patients make informed decisions based on accurate medical knowledge rather than misinformation and try to evaluate the patients' expectations. Encourage patients to ask questions and express their concerns about hormone therapy. Addressing misconceptions directly in a supportive and non-judgmental manner can help build trust and clarify misunderstandings.

Direct patients to reputable sources of information such as medical websites, professional organizations, and peer-reviewed articles. Providing brochures or handouts that explain hormone therapy can also be helpful. Physicians can actively participate on social media platforms to share accurate information and counteract misinformation. By creating educational posts, videos, and engaging in discussions, they can reach a broader audience and provide evidence-based insights.

Partnering with trusted health influencers or patient advocates who can help disseminate accurate information can be effective. Influencers with a large following can amplify the reach of evidence-based information. Sharing positive experiences from other patients who have benefited from hormone therapy can help counteract negative stories. This can be done through patient support groups, clinic websites, or social media platforms. Hosting workshops or webinars on endometriosis and its treatments can provide patients with detailed information and an opportunity to ask questions in a more structured setting. These can be recorded and shared on various platforms. Another option is to collaborate with other healthcare providers such as nutritionists, physical therapists, and mental health professionals to offer a comprehensive treatment plan. This holistic approach can address the multifaceted nature of endometriosis and reduce the reliance on potentially misleading sources. Encourage the formation of or participate in support groups where patients can share experiences under the guidance of healthcare professionals. These groups can provide a balanced view and help dispel myths. Implementing these strategies, physicians can help ensure that patients receive accurate information about hormone therapy for endometriosis and make treatment decisions based on reliable data.

When physicians approach patients on social media, several important considerations should be kept in mind to ensure effective, ethical, and professional interactions:

1. Maintain Professionalism: Always communicate in a professional manner. This includes using appropriate language, maintaining a respectful tone, and being mindful of how your posts and comments might be perceived. Don't try to adapt your language to the age of the patients.

2. Respect Privacy and Confidentiality: Never share personal health information or specific patient cases on social media without explicit consent. Adhere to HIPAA (Health Insurance Portability and Accountability Act) guidelines and other relevant privacy laws to protect patient confidentiality.

3. Provide Accurate Information: Ensure that the information shared is evidence-based, accurate, and up-to-date. Avoid spreading misinformation or unverified medical advice. Cite reputable sources and peer-reviewed studies when possible.

4. Engage Responsibly: While it's important to be responsive, set boundaries for interactions. Avoid providing specific medical advice or diagnoses in public forums. Instead, encourage patients to schedule an appointment for personalized medical advice.

5. Educate and Inform: Use social media as a platform to educate patients and the public about endometriosis, its symptoms, treatment options, and recent advancements. Share informative articles, videos, infographics, and other educational content.

6. Be Transparent: Clearly disclose your professional credentials and affiliations. Transparency about your background helps build trust and credibility with your audience.

7. Address Misinformation: Tactfully correct misinformation and myths about endometriosis and its treatment that you encounter on social media. Provide evidence-based explanations to counteract false claims.

8. Promote Resources: Direct patients to reliable resources for further information, such as reputable medical websites, professional organizations (e.g., Endometriosis Foundation of America), and peer-reviewed journals.

9. Respect Diverse Opinions: Acknowledge that patients may have diverse experiences and opinions about their treatment. Be open to listening and engaging in constructive dialogue.

10. Encourage Professional Follow-Up: When patients seek specific medical advice, encourage them to follow up with their healthcare provider. Use social media as a tool for general education rather than personalized medical consultation.

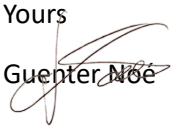
11. Stay Updated: Social media trends and platforms evolve quickly. Stay updated on best practices for using these platforms effectively and ethically. Engage in continuous learning about digital communication in healthcare.

12. Use Secure Platforms for Sensitive Discussions: If more detailed or sensitive discussions are necessary, use secure, private communication channels rather than public social media posts.

By adhering to these principles, physicians can effectively use social media to educate, support, and engage with patients while maintaining ethical and professional standards.

Overall, the discussion in the field of endometriosis treatment is dynamic and multifaceted, reflecting a shift towards more individualized, comprehensive, and less invasive approaches to managing this complex condition. This text is not a scientific reappraisal of the topic, but we as doctors must be aware of the power of information and misinformation. Therefore, with this text I would like to give you an impetus to think about activities in s.m. or at least to know about them. Doctors, especially surgeons, are sometimes very active on social media. Therefore, this should be used above all to counteract undesirable developments. The current rejection of hormonal anticonception and, consequently, the rejection of its use in endometriosis treatment is a very important aspect.

Yours



Guenter Noé

Disclosure: I used the help of *chat gpt* to create the text.

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The frontpage shows: 1) TVT placed under laparoscopic vision after previous colpo-suspension
2) Failed Sacral colpopexy with a polyester suture

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Use of imaging techniques for non-invasive diagnosis and classification of pelvic deep endometriosis – an International Consensus Statement

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Abstract

The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) and International Deep Endometriosis Analysis group (IDEA) group, the European Endometriosis League (EEL), the European Society of Gynaecological Endoscopy (ESGE), the European Society of Human Reproduction and Embryology (ESHRE), the International Society for Gynaecological Endoscopy (ISGE), the American Association for Gynecologic Laparoscopists (AAGL) and the European Society of Urogenital Radiology (ESUR) elected an international, multi-disciplinary panel of gynaecological surgeons, sonographers and radiologists, including a steering committee, which searched the literature for relevant articles to review the literature and provide evidence-based and clinically

relevant statements on the use of imaging techniques for non-invasive diagnosis and classification of pelvic deep endometriosis (DE). Preliminary statements were drafted based on the review of the relevant literature. Following 2 rounds of revisions orchestrated by chairs of participating societies, a first round of voting was carried out. Statements were revised when consensus among societies was not obtained. A second round of voting was organized to evaluate the revised version of the statements.

Twenty statements were drafted out of which 14 reached strong and 3 moderate agreements after the first voting round. The remaining three statements were discussed by all members of the steering committee and chairs of respective societies and rephrased followed by an additional round of voting. At the conclusion of the process, 14 statements received strong and 5 statements moderate agreement with 1 statement left in equipoise. This consensus work aims to guide clinicians involved in treating women with suspected endometriosis during patient assessment, counselling and planning surgical treatment strategies.

Key words:

Endometriosis, deep, imaging, ultrasound, magnetic resonance imaging, diagnosis, surgery, laparoscopy, pelvic pain, infertility

This paper has been simultaneously co-published in Ultrasound in Obstetrics & Gynecology, Facts, Views and Vision in ObGyn, The Trocar, Human Reproduction Open, Journal of Minimally Invasive Gynecology and European Journal of Radiology, by the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), the European Society for Gynaecological Endoscopy (ESGE), the European Endometriosis League (EEL), the European Society of Human Reproduction and Embryology (ESHRE), the International Society for Gynecologic Endoscopy (ISGE), the American Association of Gynecologic Laparoscopists (AAGL), the International Deep Endometriosis Analysis (IDEA) group, the European Society of Urogenital Radiology (ESUR) and Elsevier B.V.

Introduction

Reducing the diagnostic delay of endometriosis to facilitate timely action requires a shift from a surgically or lesion-oriented diagnosis to a more inclusive diagnosis where – next to symptoms and signs – non-invasive findings at examination and imaging are becoming the main drivers of clinical diagnosis and earlier intervention [1]. Various non-invasive imaging techniques have been advocated over the past decades for non- surgical visualization of pelvic endometriosis. Amongst these, ultrasound (US), primarily in its transvaginal variant, is the most commonly used imaging modality for investigation of women with suspected endometriosis besides magnetic resonance imaging (MRI) and – less commonly - computed tomography (CT) [2] or other radiological techniques such as barium enema and intravenous urography [3].

The accurate diagnosis of endometriosis with imaging tools, especially in deep endometriosis (DE), which can be observed in approximately 20% of endometriosis cases [4], is of pivotal importance for patient counselling and planning of treatment strategies. Prior to surgery, the diagnosis of DE can be used to predict operative difficulty and, equally important, in the context of infertility, particularly with ovarian endometriosis, it can assist with the guidance of treatment with surgery versus assisted reproductive technologies (ART). The latter is of specific significance with the use of predictive tools, such as the Endometriosis Fertility Index (EFI) [5-8]. Within this, Goncalves, et al. [9] published a study concluding that systematic evaluation of endometriosis by transvaginal ultrasound (TVS) can accurately replace diagnostic laparoscopy, mainly for deep and ovarian endometriosis. This view is also supported by the recently published updated version of the ESHRE (European Society of Human Reproduction and Embryology) Endometriosis Guideline [5] stating that the dogma of the need of a histological confirmation for diagnosis of endometriosis calls for an urgent need for a refinement due to the "*...advances in the quality and availability of imaging modalities for at least some forms of endometriosis on the one hand and the operative risk, limited access to highly qualified surgeons and financial implications on the other.*"

Ideally, patients with severe DE should be referred to tertiary referral centers as they may benefit from a multidisciplinary team consisting of gynecologists, urologists, colorectal surgeons and specialists in reproductive medicine and

imaging [10]. Consequently, the detailed presurgical characterization and classification of endometriosis, especially DE, is of particular importance [4]. Several attempts have been made to evaluate the use of current classification and scoring systems with non- invasive imaging techniques in order to facilitate these processes [11]. Additionally, the environmental impact of non-invasive imaging techniques for endometriosis should also be recognized in times of climate crisis. A recent study by McAllister, et al. [12], calculated the carbon footprint of imaging by MRI, CT and US in Australia.

Comparing the three different modalities, MRI exhibited the largest carbon footprint, followed by CT and US. The impact is mainly attributable to energy consumption and for a smaller part due to consumables. Hence, it should be mentioned that US has the least environmental impact and physicians should be aware when choosing an imaging technique for patients with suspected endometriosis.

The International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) and the International Deep Endometriosis Analysis (IDEA) group, the European Society for Gynaecological Endoscopy (ESGE), the European Endometriosis League (EEL), the International Society for Gynecologic Endoscopy (ISGE), the European Society of Human Reproduction and Embryology (ESHRE), the European Society of Urogenital Radiology (ESUR) and the American Association for Gynecologic Laparoscopists (AAGL) have therefore formed a working group to develop evidence-based statements to guide the use of non-invasive imaging techniques for non-invasive diagnosis and classification of endometriosis in this joint consensus statement. In the present paper, the authors focus on DE. Adenomyosis, ovarian endometrioma, superficial and extra- pelvic endometriosis, adhesions, biomarkers, economic analysis of these techniques and pathohistological and/or surgical methods for classification and diagnosis of endometriosis will not be included in this consensus statement.

Responsibilities

The following statements derive from a consensus process of all listed authors and representatives from the respective societies and do reflect current evidence-based practice and approaches for he non-invasive diagnosis and non-invasive classification of endometriosis using imaging techniques. Clinicians using these statements in everyday clinical practice are strongly recommended to apply independent medical judgement and consider the

individual situation and needs of the patient when consulting these statements. All authors listed on this work disclaim any responsibility for their use, application and clinical decisions deriving from the use of these statements.

Methodes

The present consensus statement was developed in accordance with a protocol used in a previously published consensus statement [13] involving societies also represented in this work. Using an eight-step protocol chaired and organized by Professors George Condous (G.C.) and Gernot Hudelist (G.H.), an international and multidisciplinary group was established and orchestrated by chairs of respective societies, so-called society working group chairs (G. Condous, ISUOG, IDEA; J. Keckstein, E. Saridogan, ESGE; H. Krentel, G. Hudelist, EEL; C. Becker, C: Tomassetti, ESHRE; B.J. van Herendael, ISGE; M.S. Abrao, M. Malzoni, AAGL; I. Thomassin-Naggara, ESUR) all together involving 53 experts with extensive expertise in the field of diagnosis and/or surgical treatment of endometriosis reflected by research, clinical expertise and administrative responsibilities and society leadership positions. The list of authors finally consisted of 10 radiologists with a special interest and expertise in MRI and TVS, 12 gynecologists with a special interest and expertise in gynecological ultrasound, 13 gynecologists with extensive experience in surgery for DE and gynecological ultrasound and 18 gynecologists exclusively focusing on surgery for DE.

A systematic literature review of relevant studies published from inception to February 2023 was carried out by the coordinating chairs (G.C., G.H.) and the joint first author Bassem Gerges (B.G.) using the MEDLINE, Embase, Google Scholar, PubMed and Scopus databases (Appendix 1). The literature search was limited to publications in the English language. Editorials, letters and case reports were excluded, priority was given to systematic reviews, meta-analyses and validating cohort studies. The reference list of each identified article was additionally reviewed for other potentially relevant articles. The main chairs (G.C, G.H.) and joint first author (B.G.) formulated the preliminary consensus statements and were responsible for the first draft of this work. This was followed by distribution to respective society chairs who again distributed and discussed the preliminary consensus statement with all group members followed by a first round of revisions coordinated by the representatives of each society. Statements were modified in cases of

lacking consensus among group members. The respective group members had the opportunity to provide comments/suggestions with their resubmitted versions of the draft. The society working group chairs then submitted the results and comments of the first draft to the main coordinating chairs (G.C., G.H.) and joint first author (B.G.) and suggested revisions of the statements if necessary. The revised version of the statement was resubmitted to working group chairs and thereby all group members and the process was repeated. Based on the results of the second round, the work and respective consensus statements were finalized resulting in 20 statements achieved during this process. Society group members were then able to vote binary (agree/disagree) and abstain from voting in cases of conflict of interest. Society group members were then able to vote binary (agree/disagree) and abstain from voting in cases of conflict of interest. Statements were classified as strong agreement (more than 80% agree), moderate agreement (more than 60% agree), equipoise (40%-60% agree), or disagreement (less than 40% agree). A very final version of the document was then resubmitted to all group chairs of respective societies for final approval. The summary of the supporting evidence (Appendix 2), all final consensus statements and their levels of evidence and grades are presented in this work.

Results

Transvaginal sonography (TVS)

Rectosigmoid DE

Since Bazot, et al. [14] correlated the ultrasound and surgical findings of deep pelvic endometriosis, there has been a considerable number of studies published pre- operatively assessing imaging techniques for the presence of DE, in particular rectosigmoid DE. Of these, TVS is the most studied, often used as the first-line modality given its accessibility, relatively low cost and non-invasiveness [15]. In the Cochrane review published in 2016 by Nisenblat, et al. [16], which included 14 studies, the overall pooled sensitivity and specificity for TVS was 90% and 95% respectively. In 2019, Noventa, et al. [17] performed a meta-analysis of only head-to-head TVS versus MRI studies and found the sensitivity of TVS to be 85%. Subsequently, there were two well-conducted meta-analyses, although they included a small number of studies, specifically 8 [18] and 11 [19]. Moura, et al. [18] performed a meta-analysis comparing TVS and MRI for the diagnosis of rectosigmoid DE in the same population, both of which had sensitivities and specificities of 90% and

96%, respectively. In 2020, Pereira, et al. [19] published a comparative study of TVS and MRI, including comparisons of enhanced techniques, and reported sensitivities and specificities of 80% and 94% for the former. Most recently, in 2021, Gerges, et al. [20] performed a systematic review and meta-analysis of prospective studies limited to those with at least 10 affected/unaffected patients and found an overall pooled sensitivity of all studies assessing TVS (21 studies) of 89%, and specificity of 97%. Furthermore, in their sub-group analysis of 2-D TVS (13 studies) and TVS with rectal water contrast (5 studies), the sensitivities and specificities were comparable at 84% and 97% versus 88% and 97%, respectively. A comparison of the included meta-analyses for the detection of rectosigmoid DE is summarized in Table 1.

Study	*Imaging Modality*	*No of studies*	*Total No of patients*	*Sensitivity*	*Specificity*	*LR+*	*LR-*
Hudelist et al. 2011 [77]	TVS	10	1106	0.91 (95% CI 0.88–0.94)	0.98 (95% CI 0.97–0.99)	30.36 (95% CI 15.46–59.63)	0.09 (95% CI 0.05–0.19)
Nisenblat et al. 2016 [16]	TVS	14	1616	0.90 (95% CI 0.82–0.97)	0.96 (95% CI 0.94–0.99)	22.50*	0.10*
	MRI	6	612	0.92 (95% CI 0.86–0.99)	0.96 (95% CI 0.93–0.98)	23.00*	0.08*
	RES	4	330	0.91 (95% CI 0.85–0.98)	0.96 (95% CI 0.91–1.00)	22.75*	0.09*
	CT	3	389	0.98 (95% CI 0.94–1.00)	0.99 (95% CI 0.97–1.00)	98.00*	0.02*
	DCBE	2	106	0.56 (95% CI 0.32–0.80)	0.77 (95% CI 0.41–1.00)	2.43*	0.57*
Guerriero et al. 2016 [78]	TVS	19	2639	0.91 (95% CI 0.85–0.94)	0.97 (95% CI 0.95–0.98)	33.6 (95% CI 17.8–63.5)	0.11 (95% CI 0.06–0.21)
Guerriero et al. 2018 [23]	TVS	6	424	0.85 (95% CI 0.68–0.94)	0.96 (95% CI 0.85–0.99)	20.4 (95% CI 4.7–88.5)	0.16 (95% CI 0.07–0.38)
	MRI	6	424	0.85 (95% CI 0.78–0.90)	0.95 (95% CI 0.83–0.99)	18.4 (95% CI 4.7–72.4)	0.16 (95% CI 0.11–0.24)
Medeiros et al. 2015 [36]	MRI	6	611	0.83 (95% CI 0.78–0.87)	0.88 (95% CI 0.84–0.92)	6.92*	0.19*
Moura et al. 2019 [18]	TVS	8	1132	0.90 (95% CI 0.87–0.92)	0.96 (95% CI 0.94–0.97)	20.66 (95% CI 8.71–49.00)	0.12 (95% CI 0.08–0.20)
	MRI	8	1132	0.88 (95% CI 0.85–0.91)	0.90 (95% CI 0.88–0.92)	17.26 (95% CI 3.57–83.50)	0.15 (95% CI 0.10–0.23)
Noventa et al. 2019 [17]							

TVS vs MRI	TVS	8	900	0.85 (95% CI 0.76–0.90)	0.94*	14.17*	0.16*
	MRI	8	900	0.83 (95% CI 0.76–0.88)	0.93*	11.86*	0.18*
TVS vs RES	TVS	7	710	0.89 (95% CI 0.84–0.93)	0.95*	17.80*	0.12*
	RES	7	710	0.88 (95% CI 0.84–0.91)	0.91*	9.78*	0.13*
MRI vs RES	MRI	6	842	0.84 (95% CI 0.79–0.88)	0.91*	9.33*	0.18*
	RES	6	842	0.91 (95% CI 0.87–0.94)	0.87*	7.00*	0.10*
Gerges et al. 2021 [20]	TVS	21	2857	0.89 (95% CI 0.83–0.92)	0.97 (95% CI 0.95–0.98)	30.8 (95% CI 17.6 – 54.1)	0.12 (95% CI 0.08 – 0.17)
	MRI	7	852	0.86 (95% CI 0.79–0.91)	0.96 (95% CI 0.94–0.97)	21.0 (95% CI 13.4 – 33.1)	0.15 (95% CI 0.09 – 0.23)
	RES	6	402	0.93 (95% CI 0.84–0.97)	0.95 (95% CI 0.81–0.99)	37.1 (95% CI 21.1 – 65.4)	0.08 (95% CI 0.05 – 0.14)
	CT	8	850	0.92 (95% CI 0.87–0.95)	0.98 (95%CI 90.6–0.99)	20.3 (95% CI 4.3 – 94.9)	0.07 (95% CI 0.03 – 0.19)

Table 1. Comparison of published meta-analyses on diagnostic accuracy of imaging modalities for the detection of deep endometriosis of the rectosigmoid. DCBE, double contrast barium enema; CT, computed tomography; MRI, magnetic resonance imaging; RES, transrectal endoscopic sonography; TVS, transvaginal ultrasound. * Value calculated from the available study data

Uterosacral Ligament/Torus uterine (USL), Rectovaginal Septum (RVS) and Vaginal DE

Assessment of USL DE via TVS seems to be one of the most challenging, despite DE in this region being one of the most common sites, found in up to 61% of patients at laparoscopy [21]. The performance of TVS for the pre-operative diagnosis of USL DE is relatively comparable in published meta-analyses. The first of these, in 2016, by Nisenblat, et al. [16] compared all imaging modalities and obtained a sensitivity and specificity of 64% and 97%, respectively, from a total of seven studies. Guerriero, et al published two reviews, the first in 2015 which assessed TVS, and included 11 studies, found a sensitivity and specificity of 53% and 93% [22], whilst in the more head-to-head recent review published in 2018, of which six studies

were included, the sensitivity and specificity was 67% and 86%, respectively [23]. These results were slightly lower than the head-to-head review by Noventa, et al. (13) in 2019, from which the sensitivity of TVS was 71%, likely due to the inclusion of retrospective studies. The most recent systematic review and meta-analysis in 2021 by Gerges, et al. [24], which included all prospective studies assessing all imaging modalities, found pooled sensitivities and specificities of 60% and 95%.

Similarly, the performance of TVS for the detection of RVS and vaginal DE was poorer, particularly when compared to MRI. In the first review by Guerriero, et al. [22], the sensitivity and specificity of TVS for RVS DE was 49% and 98% and vaginal DE was 58% and 96%, respectively. The results were quite similar for RVS DE in the two head- to-head reviews, with Guerriero, et al. [23] finding a sensitivity and specificity of 59% and 97%, and Noventa, et al. [17] reporting a sensitivity of 47% and a specificity of 95%. Most recently, Gerges, et al. [24], reported overall pooled sensitivities and specificities of 57% and 100% for RVS DE (7 studies) and 52% and 98% for vaginal DE (four studies), respectively. A comparison of the included meta-analyses for the detection of USL, RVS and vaginal DE are summarized in Tables 2-4. Since the IDEA consensus opinion in 2016 [25, 26], there has been further delineation of the anatomical terminology used in diagnostic imaging to define the parametrium, paracervix and uterosacral ligaments [27-29]. This is of particular significance as parametrial DE can be associated with ureteral stenosis, with associated increased operative risks and the potential need for multidisciplinary surgery. In 2021, Guerriero, et al. [30] published a systematic review and meta-analysis of the accuracy of TVS for the detection of parametrial DE, which included four studies. The pooled sensitivity was 31% and the specificity was 98%, although a positive result on TVS significantly increased the post-test probability from 18% to 79%. More recently, in a retrospective review, Roditis, et al [31], found the sensitivity and specificity for the detection of parametrial DE to be 20.7% and 97.1% for TVS, and 36% and 93.8% for MRI.

Study	*Imaging Modality*	*No of studies*	*Total No of patients*	*Sensitivity*	*Specificity*	*LR+*	*LR-*
Nisenblat et al. 2016 [16]	TVUS	7	751	0.64 (95% CI 0.50–0.79)	0.97 (95% CI 0.93–1.00)	21.33*	0.37*
	MRI	4	199	0.86 (95% CI 0.80–0.92)	0.84 (95% CI 0.68–1.00)	5.38*	0.17*

	RES	2	232	0.52 (95% CI 0.29–0.74)	0.94 (95% CI 0.86–1.00)	8.67*	0.51*
Guerriero et al. 2015 [22]	TVS	10	1482	0.53 (95% CI 0.35–0.70)	0.93 (95% CI 0.83–0.97)	7.8 (95% CI 3.7–16.4)	0.51 (95% CI 0.36–0.71)
Guerriero et al. 2018 [23]	TVS	4	261	0.67 (95% CI 0.55–0.77)	0.86 (95% CI 0.73–0.93)	4.8 (95% CI 2.6–9.0)	0.38 (95% CI 0.29–0.50)
	MRI	4	261	0.70 (95% CI, 0.55–0.82)	0.93 (95% CI 0.87–0.97)	10.4 (95% CI 5.1–21.2)	0.32 (95% CI 0.20–0.51)
Medeiros et al. 2015 [36]	MRI	11	1054	0.85 (95% CI 0.82–0.88)	0.81 (95% CI 0.77–0.84)	4.47*	0.19*
Noventa et al. 2019 [17]							
TVS vs MRI	TVS	6	636	0.71 (95% CI 0.65–0.77)	0.89*	6.45*	0.33*
	MRI	6	636	0.67 (95% CI 0.54–0.77)	0.93*	9.57*	0.35*
TVS vs RES	TVS	5	576	0.75 (95% CI 0.69–0.70)	0.84*	4.69*	0.30*
	RES	5	576	0.61 (95% CI 0.43–0.76)	0.69*	1.97*	0.57*
Gerges et al. 2021 [24]	TVS	7	108	0.60 (95% CI 0.32–0.82)	0.95 (95% CI 0.90–0.98)	13.2 (95% CI 8.0–21.8)	0.42 (95% CI 0.22–0.82)
	MRI	4	440	0.81 (95% CI 0.66–0.90)	0.83 (95% CI 0.62–0.94)	4.8 (95% CI 2.1–11.1)	0.23 (95% CI0.14–0.38)

Table 2. Comparison of published meta-analyses on diagnostic accuracy of imaging modalities for the detection of deep endometriosis of the uterosacral ligaments. MRI, magnetic resonance imaging; RES, transrectal endoscopic sonography; TVS, transvaginal ultrasound. * Value calculated from the available study data

Bladder DE

DE involving the urinary tract, namely the bladder, ureters and kidneys, is a form of DE affecting between 19-53% of women with pelvic DE, but only 1-2% of people affected by endometriosis [32]. Given the low incidence of this specific manifestation of DE, there are limited systematic reviews assessing the pre-operative diagnostic accuracy of imaging specific to the bladder DE. In 2015, Guerriero, et al. [22] performed a systematic review including prospective and retrospective studies with at least 50 participants who underwent TVS prior to surgery and found a pooled sensitivity and specificity were 62% and 100%, respectively. In 2019, Noventa, et al. [17] performed a systematic review on head-to-head studies, including

retrospective studies, with only two studies that compared TVS and transrectal endoscopic sonography (RES). They found, by univariate analysis, diagnostic odds ratios of 4.94 for TVS and 3.13 for RES. In a review of prospective studies of all imaging modalities, with at least ten affected and unaffected patients, Gerges, et al. [33] found an overall pooled sensitivity of 55%, specificity of 99%, although a meta-analysis was not able to be performed given the limited number of applicable studies. A comparison of the included meta-analyses for the detection of bladder DE is summarized in Table 5.

Study	*Imaging Modality*	*No of studies*	*Total No of patients*	*Sensitivity*	*Specificity*	*LR+*	*LR-*
Guerriero et al. 2015 [22]	TVS	8	1248	0.62 (95% CI 0.40–0.80)	1.00 (95% CI 0.97–1.00)	208.4 (95% CI 21.0–2066.0)	0.38 (95% CI 0.22–0.66)
Medeiros et al. 2015 [36]	MRI	5	586	0.64 (95% CI 0.48–0.77)	0.98 (95% CI 0.96–0.99)	31.00*	0.37*
Gerges et al. 2021 [33]	TVS	8	1052	0.55 (95% CI 0.28–0.79)	0.99 (95% CI 0.98–1.00)	54.5 (95 % CI 18.9–157.4)	0.46 (95 % CI 0.25 – 0.85)

Table 5. Comparison of published meta-analyses on diagnostic accuracy of imaging modalities for the detection of deep endometriosis of the bladder. MRI, magnetic resonance imaging; TVS, transvaginal ultrasound. * Value calculated from the available study data

Magnetic resonance imaging (MRI)

Rectosigmoid DE

With regards to rectosigmoid DE, in 2016, Nisenblat, et al. [16] included a total of six studies with an overall sensitivity and specificity of 92% and 96%. More recently, in 2019 Noventa, et al. [17] performed a meta-analysis of only head-to-head studies and found the pooled sensitivity and specificity for MRI of 83% and 93% when compared to that of TVS at 85% and 94%, and 84% and 91% when compared to RES at 91% and 87%. Moura, et al. [18] performed a meta-analysis comparing MRI and TVS in the diagnosis of rectosigmoid DE in the same population. Both modalities were found to have similar sensitivity and specificity of 88% and 90%, and 90% and

96%, respectively. In 2020, Pereira, et al. [19] published a comparative study of MRI and TVS, including comparisons of enhanced techniques, and reported sensitivities and specificities of 82% / 94%, and 80% / 94%, respectively. However, the latter two meta- analyses [18] [19], although well conducted, included a small number of studies, namely eight and eleven, respectively. More recently, in 2021, Gerges, et al. [20] performed a systematic review and meta-analysis of prospective studies limiting studies to those with at least 10 affected/unaffected patients found the sensitivity and specificity of all studies assessing MRI (7 studies; 852 patients) to be 86% and 96%, whilst the sub-analysis of 2D MRI (5 studies; 813 patients) was very similar with a sensitivity and specificity of 85% and 96%. Due to the limited number of studies, sub- analyses were not performed. In a study assessing interobserver agreement, 3-D MRI performed similarly to 2-D MRI for the detection of rectosigmoid DE, with sensitivities and specificities between radiologists ranging from 89-100% and 94-100%, [34], while MRI with rectal ultrasound gel outperformed 2-D MRI with a sensitivity of 99% and specificity of 96% [35]. A comparison of the included meta-analyses for the detection of rectosigmoid DE is summarized in Table 1.

Uterosacral Ligament/Torus uterinus (USL), Rectovaginal Septum (RVS) and Vaginal DE

MRI generally outperforms TVS for the detection of USL DE. Nisenblat, et al. [16] compared all imaging modalities and found sensitivities and specificities of MRI (4 studies) for the detection of USL DE of 86% and 84%, compared with 64% and 97%, respectively, for TVS (7 studies). In the head-to-head review in 2018 by Guerriero, et al. [23], a total of six studies were included, from which the sensitivity and specificity, respectively, for the detection of USL DE for MRI was 70% / 93% compared with 67% / 86% for TVS. Similarly, with RVS DE, the sensitivity and specificity for MRI was 66% and 97% compared with 59% and 97% for TVS. In contrast, Noventa, et al. [17] performed a head-to-head meta-analysis including retrospective studies and found TVS to be slightly superior to MRI with sensitivities and specificities of 71% / 89% and 67% /93%, for the detection of USL DE. In contrast, the sensitivities and specificities for the detection of RVS DE were 47% / 95% for TVS and 61% / 92% for MRI. In a meta-analysis assessing the performance of MRI, Medeiros, et al. [36] reported sensitivities and specificities for USL DE, RVS DE and vaginal DE of 85% / 80%, 77%

/ 95% and 82% / 82%, respectively. Similarly, the meta-analysis of prospective studies by Gerges, et al. [24] found MRI to consistently outperform TVS with sensitivities and specificities for USL DE of 81% / 83% and 60% / 95% respectively, for vaginal DE of 64% / 98% and 52% / 97%, respectively. A comparison of the included meta-analyses for the detection of USL, RVS and vaginal DE are summarized in Tables 2-4.

Study	*Imaging Modality*	*No of studies*	*Total No of patients*	*Sensitivity*	*Specificity*	*LR+*	*LR-*
Nisenblat et al. 2016 [16]	TVS	10	983	0.88 (95% CI 0.82–0.94)	1.00 (95% CI 0.98–1.00)	–*	0.12*
	MRI	3	288	0.81 (95% CI 0.70–0.93)	0.86 (95% CI 0.78–0.95)	5.79*	0.22*
	RES	2	232	0.78 (95% CI 0.51–1.00)	0.96 (95% CI 0.89–1.00)	19.50*	0.23*
Guerriero et al. 2015 [22]	TVS	10	1482	0.49 (95% CI 0.36–0.62)	0.98 (95% CI 0.95–0.99)	26.9 (95% CI 10.2–71.3)	0.52 (95% CI 0.40–0.67)
Guerriero et al. 2018 [23]	TVS	5	365	0.59 (95% CI 0.26–0.86)	0.97 (95% CI 0.94–0.99)	23.5 (95% CI 9.1–60.5)	0.42 (95% CI 0.18–0.97)
	MRI	5	365	0.66 (95% CI 0.51–0.79)	0.97 (95% CI 0.89–0.99)	22.5 (95% CI 6.7–76.2)	0.38 (95% CI 0.23–0.52)
Medeiros et al. 2015 [36]	MRI	7	753	0.77 (95% CI 0.69–0.83)	0.95 (95% CI 0.92–0.96)	15.40*	0.24*
Noventa et al. 2019 [17]							
TVS vs MRI	TVS	7	715	0.47 (95% CI 0.84–0.93)	0.95*	9.40*	0.56*
	MRI	7	715	0.61 (95% CI 0.48–0.72)	0.92*	7.63*	0.58*
TVS vs RES	TVS	5	574	0.39 (95% CI 0.13–0.73)	0.95*	7.80*	0.64*
	RES	5	574	0.55 (95% CI 0.22–0.84)	0.89*	5.00*	0.51*
MRI vs RES	TVS	5	601	0.55 (95% CI 0.41–0.67)	0.94*	9.17*	0.48*
	RES	5	601	0.55 (95% CI 0.22–0.84)	0.89*	5.00*	0.51*
Gerges et al. 2021 [24]	TVS	7	1005	0.57 (95% CI 0.30–0.80)	1.00 (95% CI 0.92–1.00)	147.1 (95% CI 7.5–2895.2)	0.44 (95% CI 0.23–0.81)

Table 3. Comparison of published meta-analyses on diagnostic accuracy of imaging modalities for the detection of deep endometriosis of the rectovaginal septum. MRI, magnetic resonance imaging; RES, transrectal endoscopic sonography; TVS, transvaginal ultrasound. * Value calculated from the available study data

Study	Imaging Modality	No of studies	Total No of patients	Sensitivity	Specificity	LR+	LR-
Nisenblat et al. 2016 [16]	TVS	6	679	0.57 (95% CI 0.21–0.94)	0.99 (95% CI 0.96–1.00)	57.00*	0.43*
	MRI	4	248	0.77 (95% CI 0.67–0.88)	0.97 (95% CI 0.92–1.00)	25.67*	0.67*
	RES	2	232	0.39 (95% CI 0.08–0.70)	1.00 (95% CI 1.00–1.00)	–*	0.61*
Guerriero et al. 2015 [22]	TVS	9	965	0.58 (95% CI 0.40–0.74)	0.96 (95% CI 0.87–0.99)	15.3 (95% CI 4.6–51.3)	0.44 (95% CI 0.29–0.66)
Medeiros et al. 2015 [36]	MRI	9	1021	0.82 (95%CI 0.76–0.86)	0.82 (95% CI 0.76–0.86)	4.56*	0.22*
Gerges et al. 2021 [24]	TVS	4	451	0.52 (95% CI 0.29–0.74)	0.98 (95% CI 0.95–0.99)	27.1 (95% CI 12.0–61.4)	0.49 (95% CI 0.30–0.80)
	MRI	3	137	0.64 (95% CI 0.40–0.83)	0.98 (95% CI 0.83–0.99)	27.5 (95% CI 8.4–90.8)	0.37 (95% CI 0.19–0.69)

Table 4. Comparison of published meta-analyses on diagnostic accuracy of imaging modalities for the detection of deep endometriosis of the vagina. MRI, magnetic resonance imaging; RES, transrectal endoscopic sonography; TVS, transvaginal ultrasound. * Value calculated from the available study data

Bladder DE

The studies assessing the diagnostic accuracy of imaging techniques for bladder DE are quite limited, largely due to the low incidence of the disease. Medeiros, et al. [36] reviewed MRI for the diagnosis of bladder DE including both, retrospective and prospective studies allowing them to perform a pooled analysis for the detection of bladder DE. They found a pooled sensitivity and specificity of 64% and 98%, respectively. In a review of prospective studies [33], while pooled analyses could not be performed due to the limited number of studies, there were two which assessed 2- D MRI with reported sensitivities ranging from to 50% [37] to 100% [38] and specificities ranging from to 97% [37] to 100% [38]. Within this, MRI with rectal ultrasound gel performed similarly with a sensitivity of 70% and specificity of 100% [35]. A comparison of the included meta-analyses for the detection of bladder DE is summarized in Table 5.

Computed tomography (CT)

The use of CT for the pre-operative detection of endometriosis is less studied than TVS and MRI, mostly used for the detection of rectosigmoid DE. In the 2021

systematic review by Gerges, et al [20], six studies were included which assessed standard CT (402 patients), with three assessing CT [39-41] and three assessing CT with water enema [42-44]. The overall pooled sensitivity and specificity of CT for the detection of rectosigmoid DE were 93% and 95%. Sub-analyses of CT colonography were not performed, although the results ranged widely with one study [42] performing poorly with a sensitivity and specificity of 68% and 67%, compared with the other two publications, ranging from 93 – 95% and 87 – 93% [43, 44]. In the review by Nisenblat, et al in 2016 [16], these results were improved when CT was combined with water enema, with three studies (389 patients) [40-42] included, resulting in a pooled sensitivity and specificity of 98% and 99%, respectively. However, the authors did state that this technique should be avoided in young patients whenever possible due to the radiation exposure [45]. This is consistent with the "ALARA" principle of ensuring that the exposure to radiation is "as low as reasonably achievable" [46].

General remarks on imaging

The test performance of any imaging technique is operator dependent and will increase with exposure, level of training and skills and experience of the operator. Also, as systematic reviews, per definition, include older studies, and because the expertise in endometriosis imaging of endometriosis has dramatically improved worldwide in the last few years, it can reasonably be assumed that the published sensitivity figures are an underestimation of the current status. Consequently, the following statements should be interpreted based on these assumptions. Also, whilst these imaging techniques have been compared to each other in the various anatomical areas above, they can be complimentary and do not need to be used exclusively [3]. Within this, a recent analysis of the combined use of vaginal palpation, TVS and MRI with at least two positive tests was observed as the most valid model for diagnosing DE with an accuracy of 91.4% [47].

Non-invasive use of classification and scoring systems for endometriosis: (#)Enzian, AAGL score, Endometriosis Fertility Index (EFI), deep Pelvic Endometriosis Index (dPEI), revised American Society of Reproductive

Medicine (rASRM) score, and Ultrasound Based Endometriosis Scoring System (UBESS)

Classification and scoring systems for topographical description and extent of

endometriosis and associated secondary adhesions have been proposed and used in multitude over decades with varying rates of recognition amongst clinicians, radiologists, sonographers and gynecological surgeons [48].

TVS for description and classification of DE

Terms and definitions for uniform and standardized description of DE across different centers and countries have been proposed by the IDEA group and have been consequently widely accepted [25]. These definitions primarily serve as a standardized terminology for describing DE with ultrasound. Their use, applicability and accuracy as well as reproducibility is currently under investigation in an international multicentered study level. Within this, Leonardi et al. [49] recently published the results of a pilot study on the accuracy of IDEA terms and definitions for presurgical detection of DE. Two-hundred and seventy-three women were included, out of which 256 (93.8%) had endometriosis with 190 (74.2%) DE cases. In these women, the diagnostic accuracy was 86.1%; sensitivity, 88.4%; specificity, 78.8%; positive predictive value (PPV), 92.9%; negative predictive value (NPV), 68.4%; LR+, 4.17; LR-, 0.15. Within this, Szabo et al. [26] demonstrated a diagnostic accuracy, sensitivity, specificity, NPV, PPV, LR+ and LR- of 94%, 93.5%, 94.6%, 93.1%, 94.9%,
17.24 and 0.07, respectively, for TVS diagnosing colorectal DE applying the IDEA criteria in 537 women with suspected endometriosis.

Amongst all scoring and/or classification systems published so far, the revised American Society of Reproductive Medicine (ASRM) score [50] (Figure 1), the (#)Enzian classification [51], [52] (Figure 2), the Ultrasound based Endometriosis Staging System (UBESS) [53] (Figure 3), the Endometriosis Fertility Index (EFI) [6, 8] (Figure 4) for prediction of conception following surgery for endometriosis and the AAGL Endometriosis Classification [54] have also been investigated for their non-invasive applicability using TVS and/or MRI. In the ideal scenario, description of endometriosis via scoring and classification systems should be possible for surgeons and radiologists and/or sonographers to speak one common language to facilitate communication and clinical research.

As a consequence, there have been efforts to investigate the possibility of using the rASRM score with TVS. The score divides grades of severity of endometriosis into 4 stages – minimal, mild, moderate and severe taking into account endometriotic lesions affecting the pelvic peritoneum,

ovaries and associated adhesions. Points are counted and added to a score dependent whether the lesion is deep or superficial, the size of the endometriotic lesion, and the type (filmy or dense) and extent of adhesions involving the fallopian tubes, ovaries, and the pouch of Douglas. Leonardi et al. [55] retrospectively investigated the accuracy of TVS for staging of endometriosis pre-operatively in 204 patients using the rASRM classification. When evaluating stages separately, sensitivities, specificities, PPVs and NPVs of TVS were 18.2%, 94.7%, 80% and 49.7% for rASRM stage 1; 22.7%, 96.7%, 45.5% and 91.2% for stage 2; 62.5%, 92.0%, 40.0% and 96.7% for stage 3; and 71.9%, 97.1%, 82.1% and 94.9% for stage 4. Similar to Leonardi et al. who observed lower accuracies for TVS in minimal and mild rASRM stage disease, Holland et al. [56] found a low sensitivity for TVS diagnosing minimal and mild endometriosis but an accuracy of 94% for TVS for detecting moderate and severe disease. Of note, both authors observed low diagnostic accuracy for TVS in the detailed assessment of DE due to the fact that DE could not be clearly scored using the rASRM classification. Finally, Tomassetti et al.
[6] found good agreement using TVS for estimating the Endometriosis Fertility Index (EFI) which is partly based on the rASRM. So far, there have been no attempts to use MRI in combination with the rASRM score to describe and diagnose endometriosis.

To better describe DE using a classification system, the ENZIAN classification was developed in 2003 [51] and further extended and modified in 2021 [52]. So far, five studies have evaluated the accuracy of TVS in combination with the ENZIAN classification. Hudelist et al. [57] compared TVS findings with surgical findings in 195 women with DE and found good agreement between these modalities especially for ENZIAN compartments A (vagina, rectovaginal space), C (rectum) and FB (urinary bladder. TVS detected DE in compartments A, B, C, and FB with sensitivity 84%, 91%, 92%, and 88%, respectively, and specificity 85%, 73%, 95%, and 99%. Recently, Enzelsberger et al. [58] evaluated the preoperative use of the ENZIAN classification using TVS and/or MRI in a prospective multicenter study including 1062 women undergoing surgery for endometriosis observing lower accuracies for TVS and/or MRI for compartments A, B and C. An exact concordance regarding compartment and grade 1, 2 or 3 was observed in 369 women (35.14% of 1050 valid ratings) which increased to 40.3% when categorizing the numerical ratings in compartments A/B/C into ‘affected’

(combining values 1, 2 and 3) and 'not affected' (0 coded). Overall consistency, sensitivities, specificities, PPVs and NPVs for compartment A were 83%, 63%, 91%, 72% and 88%; compartment B 69%, 47%, 86%, 72%, 68% and C 89%, 52%, 96%, 76% and 91%, respectively. However, it needs to be mentioned that MRI *or* TVS could be applied and that TVS was also performed by sonographers with limited experience in scanning DE which limit the results of the study regarding the accuracy of TVS when used in combination with the ENZIAN classification.

In order to test the accuracy of the modified, so-called #ENZIAN classification which also takes into account peritoneal and ovarian endometriosis and secondary tubal adhesions and has been shown to outperform the ASRM score regarding the description of DE [59], Di Giovanni et al. [60] retrospectively investigated 93 patients undergoing TVS using the #Enzian classification followed by surgery and observed sensitivities and specificities for TVS – verified endometriosis in compartments O (ovary) right/left: 100% and 100%/100% and 96%, A: 97% and 86, B right/left: 100%
and 90%/97% and 70%, C: 100% and 96%, FB: 86% and 100%, FI (intestines): 100% and 100%, and FU (ureter): 100% and 100%, respectively. Similarly, Bindra et al. [61] retrospectively reviewed 50 patients undergoing surgery following TVS mapping used with #Enzian observing similar accuracy values. Recently, Montanari et al. [62] evaluated the use of the #Enzian classification in a prospective, multicentered study including 745 patients undergoing TVS and surgery for DE. The sensitivities for the detection of endometriotic lesions ranged from 50% (#Enzian compartment FI - other intestinal locations) to 95% (#Enzian A), specificities from 86% (#Enzian T left) to 99% (#Enzian FI) and 100% (#Enzian FB - urinary bladder, FU - ureters and FO - other extragenital locations) with positive predictive values of 90% (#Enzian T right) to 100%

(#ENZIAN FO), negative predictive values of 74% (#ENZIAN B left) to 99% (#ENZIAN FB and FU) and accuracies of 88% (#ENZIAN B right) to 99% (#ENZIAN FB) underlining that presence and extent of DE can be accurately evaluated using TVS in combination with the #ENZIAN classification.

In order to stage disease extent and predict the complexity of surgery in patients with DE, the UBESS was created based on anatomical locations of DE and sonographic markers of local

invasiveness [53]. In a multicenter prospective and retrospective cohort study on 192 consecutive women with suspected endometriosis, three stages of UBESS (I-III) were correlated with the three levels of complexity of laparoscopic surgery. The need (accuracy, sensitivity, specificity, positive and negative predictive values and positive and negative likelihood ratios) for advanced laparoscopic surgery reflected by UBESS stage III were 95.3%, 94.8%, 95.5%, 90.2%, 97.7%, 21.2 and 0.054, respectively [53]. External validation of the UBESS showed little predictive value for surgical difficulty of the UBESS in a small number of 33 patients [63] and problems with generalizability in cases lacking bowel DE or obliteration of the pouch of Douglas [64].

Amongst other classification and scoring systems that have been proposed [48], the recently published AAGL classification [54] and the EFI [8] should be mentioned. Recently, Abrao, et al. [65] evaluated the AAGL Endometriosis Classification by ultrasound and showed that the sonographic estimation of the 2021 AAGL Endometriosis staging is greatest in AAGL stages 1 and 4 and reliably distinguishes AAGL stages 1/2 from 3/4. They found that ultrasound best identified endometriosis of the ovaries, bladder, and bowel but was more limited for the tubes and superficial peritoneum. The EFI primarily works as a model to predict fertility outcomes following surgery for endometriosis. It constitutes of a 10-point scoring system based on factors such as patient characteristics (age, duration of infertility and history of prior pregnancy), the rASRM classification and functionality of fallopian tubes and ovaries during surgery. So far, one study demonstrated the possibility of applying the EFI with ultrasound instead of invasive methods showing that the prediction model can be assessed using TVS-based tubal patency testing with a 10% loss of accuracy compared with the invasive EFI [6].

MRI for description and classification of DE

Two consensus MRI lexicons [66, 67] from the Society of Abdominal Radiology (SAR) and from the French Society of Women's Imaging (SIFEM) were recently published. In these two MRI consensus lexicons, the different locations of DE are described according to a compartment-based approach of the pelvic. The most recent one emphasized the description of lateral compartments which are usually difficult to detect with TVS and crucial for surgical planning.
To date, seven studies investigated the use of the ENZIAN classification with

MRI with good agreement rates between radiological and surgical findings except for B compartment lesions [68], [69], [70], [71]. Manganaro, et al. [72] and Burla, et al. [73] showed that the ENZIAN classification based on MRI findings is also reproducible. In addition, Thomassin-Naggara, et al. [74] also demonstrated that DE lesions in compartment A and C with ENZIAN classification were accurate in predicting operating time, hospital stay and post operative complications according to Clavien-Dindo. However, Thomassin-Naggara et al. highlighted the poor reproducibility of the description of B lesions due to the difficulty of measuring USL on MRI. The same limitation was described in a recent prospective international multi-center study performed in 12 centers and 1062 women [75] which demonstrated that the MRI based and surgical ENZIAN classifications were concordant for DE lesions in compartment A in 78.7% (118/150), for C lesions in 82.7% (124/150) but only in 34.7% (52/150) for B lesions. In this setting, another MRI classification was published in 2020 [74], named the deep pelvic endometriosis index (dPEI) classification, demonstrated a high reproducibility (kappa = 0,74), including the USL (Figure 5). This MRI classification includes the description of lateral compartments and accurately predicts operating time, hospital stay and postoperative complications [76]. Larger prospective European and American validation studies on the use MRI-based use of #ENZIAN and dPEI classifications are ongoing.

Statements on the use of imaging techniques for non-invasive diagnosis and classification of endometriosis

General statements

The test performance of any imaging technique for the detection of DE is operator dependent and will increase with exposure, level of training and skills and experience of the operator.

Consensus: yes 96.2% (n=51); no 0% (n=0), abstain 3.8% (n=2)

Patients with a plan for surgical intervention for endometriosis should undergo pre-operative imaging for the detection of DE performed by adequately trained operators.

Consensus: yes 96.2% (n=51); no 0% (n=0), abstain 3.8% (n=2)

Transvaginal sonography performed by adequately trained operators is recommended as first-line imaging tool due to its availability, good test performance, cost efficacy and its low environmental impact when compared to other imaging methods.

Level of evidence: 1a

Grade of statement: A

Consensus: yes 96.2% (n=51); no 0% (n=0), abstain 3.8% (n=2)

Statements on ultrasonography

Imaging with TVS can reliably pre-operatively predict, and is recommended, to detect the presence DE of the rectum but is less accurate in sigmoidal DE due to limited visibility

Level of evidence: 1a

Grade of statement: A

Consensus: yes 86.8% (n=46); no 5.7% (n=3), abstain 7.6% (n=4)

Imaging with TVS can help to pre-operatively predict the presence of DE of the rectovaginal septum

Level of evidence: 1a

Grade of statement: B

Consensus: yes 83.0% (n=44); no 3.8% (n=2), abstain 13.2% (n=7)

Imaging with TVS can help to pre-operatively predict the presence of DE of the vagina, uterosacral ligaments and parametrium

Level of evidence: 1a

Grade of statement: B

Consensus: yes 73.6% (n=39); no 18.9% (n=10), abstain 7.6% (n=4)

Imaging with TVS can help to pre-operatively predict the presence of DE of the bladder Level of evidence: 1a

Grade of statement: B

Consensus: yes 90.6% (n=48); no 1.9% (n=1), abstain 7.6% (n=4)

Statements on MRI and CT

Imaging with MRI can reliably pre-operatively predict the presence of DE of the rectosigmoid

Level of evidence: 1a

Grade of statement: A

Consensus: yes 90.6% (n=48); no 5.7% (n=3), abstain 3.8% (n=2)

Imaging with MRI can reliably pre-operatively predict the presence of DE of the uterosacral ligaments and torus uterinus

Level of evidence: 1a

Grade of statement: B

Consensus: yes 88.7% (n=47); no 0% (n=0), abstain 11.3% (n=6)

Imaging with MRI is helpful to pre-operatively predict the presence of DE of the rectovaginal septum

Level of evidence: 1a

Grade of statement: B

Consensus: yes 90.6% (n=48); no 3.8% (n=2), abstain 5.7% (n=3)

Imaging with MRI can reliably pre-operatively predict the presence of DE of the vagina Level of evidence: 1a

Grade of statement: B

Consensus: yes 86.8% (n=46); no 3.8% (n=2), abstain 9.4% (n=5)

Imaging with MRI can reliably pre-operatively predict the presence DE of the bladder

Level of evidence: 1a

Grade of statement: B

Consensus: yes 92.5% (n=49); no 3.8% (n=2), abstain 3.8% (n=2)

Imaging with CT may reliably pre-operatively predict the presence of DE of the rectosigmoid but is less studied than other imaging modalities. There are, however, no obvious advantages compared to MRI as well as the disadvantage of radiation exposure.

Level of evidence: 2a

Grade of statement: B

Consensus: yes 69.8% (n=37); no 22.6% (n=12), abstain 7.6% (n=4)

There is insufficient evidence to support, compared to other imaging modalities, for the use of CT for the detection of deep endometriosis of the uterosacral ligaments/torus uterinus, rectovaginal septum, vagina or bladder

Level of evidence: 2a

Grade of statement: D

Consensus: yes 90.6% (n=48); no 1.9% (n=1), abstain 7.6% (n=4)

Statements on the non-invasive use of classification systems

Imaging with TVS in combination with the rASRM score can help describe moderate to severe endometriosis but is less accurate in cases of minimal to mild disease as classified with the rASRM score

Level of evidence: 4

Grade of statement: D

Consensus: yes 62.3% (n=33); no 7.6% (n=4), abstain 30.2% (n=16)

Imaging with TVS and in combination with the (#)Enzian classification can reliably describe deep endometriosis, ovarian endometriosis and adhesions but is less accurate in cases of parametrial involvement (B compartment).

Level of evidence: 1a

Grade of statement: B

Consensus: yes 83.0% (n=44); no 3.8% (n=2), abstain 13.2% (n=7)

Imaging with MRI and in combination with the (#)Enzian classification can reliably describe rectal and rectovaginal deep endometriosis, ovarian endometriosis but is less accurate in cases of USL and/or parametrial involvement (B compartment) and adhesions.

Level of evidence: 4

Grade of statement: B

Consensus: yes 81.1% (n=43); no 5.7% (n=3), abstain 13.2% (n=7)

Imaging with TVS and in combination with the UBESS classification may help to estimate surgical complexity but the predictive value is not yet generalizable.

Level of evidence: 3b

Grade of statement: B

Consensus: yes 64.2% (n=33); no 5.7% (n=3), abstain 30.2% (n=16)

Imaging alone with TVS and in combination with the EFI prediction cannot be reliably used as a substitute for the EFI generated by invasive, i.e. surgical methods.

Level of evidence: 4

Grade of statement: D

Consensus: yes 62.3% (n=33); no 7.6% (n=4), abstain 30.2% (n=16)

Imaging alone with TVS in combination with the AAGL classification may be used as a substitute for the AAGL classification generated by invasive, i.e. surgical methods.

Level of evidence: 2b

Grade of statement: C

Consensus: yes 50.9% (n=27); no 28.3% (n=15), abstain 20.8% (n=11)

Overview of consensus, discussion and conclusions

The present work represents a consensus opinion regarding use of imaging methods and non-invasive application of classification systems for the detection of DE, specifically when using TVS or MRI. The test performance of any imaging technique is operator dependent. Imaging with TVS and MRI needs to be performed by well- trained medical staff. TVS is recommended as first-line imaging tool due to its availability, good test performance, cost efficacy and its low environmental impact, although it is acknowledged that many centers adopt MRI as first line technique which is also appropriate.

There was strong agreement that TVS assessment of patients with suspected DE will accurately determine or rule out the presence of DE affecting the rectum, rectovaginal septum and bladder but is less precise in locations such as the parametrium and the uterosacral ligaments. However, the detection of DE of the uterosacral ligaments and parametrium using TVS is evolving and has been constantly improving. Similarly, MRI- based imaging is capable of detecting DE in these locations and a consensus was reached that MRI can reliably predict the presence of uterosacral ligament, parametrial and rectovaginal septum DE.

The use of classification systems for DE is a matter of constant debate. There was moderate agreement on the non-invasive use of rASRM, UBESS classification systems and EFI prediction model and equipoise on the usefulness of the TVS-based use of the AAGL score. The majority of participants strongly agreed on the use of TVS and MRI in combination with the (#)ENZIAN classification although it is less accurate in cases of parametrial und USL involvement. Future studies on rASRM, AAGL, UBESS, EFI and (#)ENZIAN will hopefully further clarify their future role in these settings.

It is noteworthy that the reference standards of many of the published studies have been laparoscopy, with/without histopathology. Hence, it is difficult to ascertain the limitation of operator expertise, or a reference standard which could be used in women who are managed conservatively. While this paper is focused on non-invasive imaging primarily for planning surgery, it is not the only aspect of endometriosis treatment, with at least 40% of women with DE being asymptomatic. In those with symptoms, it is not necessarily

clear that these are caused by or coincide with endometriosis. Therefore, the statements made within this paper primarily pertain to women with symptomatic disease with a possible plan for surgical treatment. The combination assessment of women with potential DE with non-invasive imaging with TVS and/or MRI by adequately trained clinicians with planning of surgical and/or conservative management approaches should be the standard of care in health care facilities offering endometriosis therapy.

APPENDICES:

Appendix 1.

Identification of scientific evidence (literature research MEDLINE).

1	deep.mp.	281819
2	endometriosis.mp. or exp Endometriosis/	30750
3	1 and 2	2004
4	imaging.mp.	2264021
5	ultrasound.mp.	284805
6	sonography.mp.	34198
7	magnetic resonance.mp.	816546
8	shift imaging.mp.	1092
9	exp Magnetic Resonance Imaging/	503906
10	proton spin.mp.	735
11	spin echo.mp.	15398
12	MRI.mp.	287756
13	NMR.mp.	191443
14	exp Tomography, X-Ray Computed/ or computed tomography.mp	612390
15	computer assisted tomography.mp.	824
16	beam tomography.mp.	566

17	Computerized Axial Tomography.mp.	1339
18	CT.mp.	392841
19	CAT.mp.	123972
20	4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18	3080240
21	3 and 20	692

Appendix 2.

Levels of evidence and grades of statement used in this work. (Oxford Centre for Evidence-Based Medicine (CEBM))

1a: Systematic review (with homogeneity) of Level-1 diagnostic studies; or clinical decision rule with Level-1b studies from different
clinical centers

1b: Validating cohort study with good reference standards; or clinical decision rule tested within one clinical center

1c: Absolute SpPins and SnNouts*

2a: Systematic review (with homogeneity) of Level>2 diagnostic studies

2b: Exploratory cohort study with good reference standards; or clinical decision rule after derivation, or validated only on split-sample or databases

3a: Systematic review (with homogeneity) of studies Level≥3b

3b: Non-consecutive study; or without consistently applied reference standards

4: Case–control study, poor or non-independent reference standard

5: Expert opinion without explicit critical appraisal, or based on physiology, bench research or 'first principles'

A High: Further research is very unlikely to change our confidence in the estimate of effect.

- Several high-quality studies with consistent results
- In special cases: one large, high-quality multicenter trial

B Moderate: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

- One high-quality study
- Several studies with some limitations

C Low: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

- One or more studies with severe limitations

D Very low: Any estimate of effect is very uncertain.

- Expert opinion
- No direct research evidence
- One or more studies with very severe limitations

Note: A minus sign '–' may be added to denote evidence that fails to provide a conclusive answer because it is either (a)

a single result with a wide confidence interval; or (b) a systematic review with considerable heterogeneity. Such evidence is inconclusive, and therefore can only generate Grade D recommendations. *'Absolute SpPin' is a diagnostic finding whose specificity is so high that a positive result rules in the diagnosis; 'Absolute SnNout' is a diagnostic finding whose sensitivity is so high that a negative result rule out the diagnosis.

Appendix 3 (Figures)

Figure 1. The revised American Society for Reproductive Medicine classification of endometriosis [50].

AMERICAN SOCIETY FOR REPRODUCTIVE MEDICINE
REVISED CLASSIFICATION OF ENDOMETRIOSIS

Patient's Name _____ Date _____

Stage I (Minimal) - 1-5
Stage II (Mild) - 6-15
Stage III (Moderate) - 16-40
Stage IV (Severe) - >40
Total _____

Laparoscopy _____ Laparotomy _____ Photography _____
Recommended Treatment _____
Prognosis _____

PERITONEUM	ENDOMETRIOSIS	<1cm	1-3cm	>3cm
	Superficial	1	2	4
	Deep	2	4	6
OVARY	R Superficial	1	2	4
	Deep	4	16	20
	L Superficial	1	2	4
	Deep	4	16	20
	POSTERIOR CULDESAC OBLITERATION	Partial	Complete	
		4	40	
OVARY	ADHESIONS	<1/3 Enclosure	1/3-2/3 Enclosure	>2/3 Enclosure
	R Filmy	1	2	4
	Dense	4	8	16
	L Filmy	1	2	4
	Dense	4	8	16
TUBE	R Filmy	1	2	4
	Dense	4*	8*	16
	L Filmy	1	2	4
	Dense	4*	8*	16

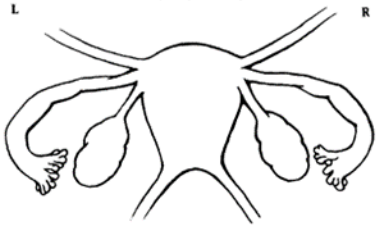
*If the fimbriated end of the fallopian tube is completely enclosed, change the point assignment to 16.

Denote appearance of superficial implant types as red [(R), red, red-pink, flamelike, vesicular blobs, clear vesicles], white [(W), opacifications, peritoneal defects, yellow-brown], or black [(B) black, hemosiderin deposits, blue]. Denote percent of total described as R___%, W___% and B___%. Total should equal 100%.

Additional Endometriosis: _____

Associated Pathology: _____

To Be Used with Normal Tubes and Ovaries



To Be Used with Abnormal Tubes and/or Ovaries

Figure 2. The #ENZIAN staging system for women with deep endometriosis developed as a supplement to the revised American Society for Reproductive Medicine score, in order to provide detailed descriptions of the retroperitoneal structure. [52].

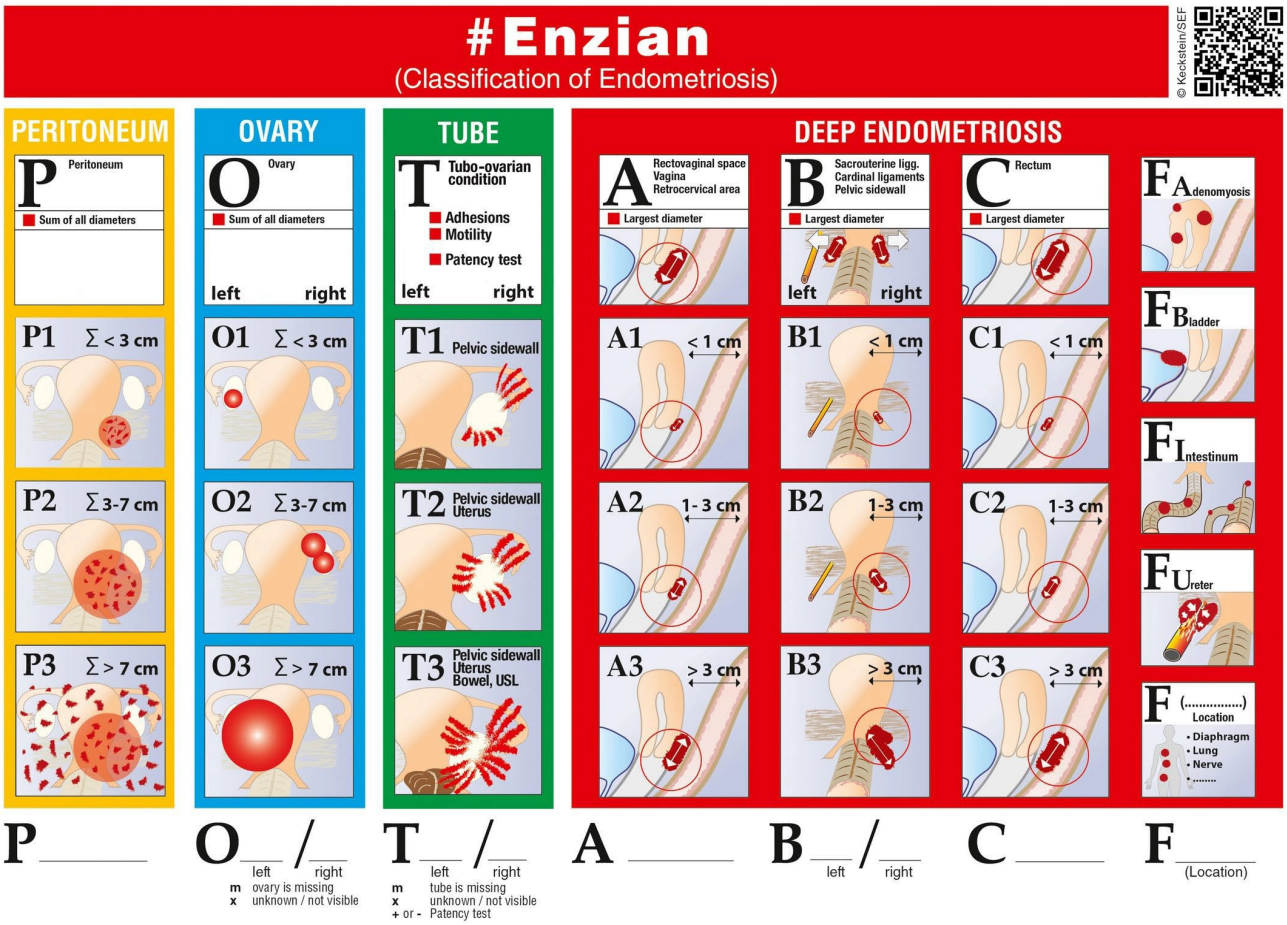


Figure 3. Ultrasound-based endometriosis staging system (UBESS) with sonographic features demonstrable on transvaginal ultrasound (TVS) and its prediction of level of surgical complexity [53].

UBESS stage	Features demonstrable on TVS + gel SVG	Level of surgical complexity
Stage I	Normal mobile ovaries, absent non-bowel and absent bowel DIE, normal POD +/– SST	Level 1: negative laparoscopy or mild stage disease
Stage II	Endometrioma +/– immobile ovaries +/– non-bowel DIE +/– normal POD	Level 2: moderate stage disease
Stage III	Bowel DIE +/– immobile ovaries (endometriomas) +/– non-bowel DIE +/– normal POD	Level 3: higher stage disease

+/–,with or without;

DIE, deep infiltrating endometriosis; POD, pouch of Douglas; SST, site-specific tenderness.

Figure 4. Endometriosis fertility index (EFI) system. This score predicts the fertility outcome for women who attempt non- in vitro fertilization conception following surgically documented endometriosis [8].

ENDOMETRIOSIS FERTILITY INDEX (EFI) SURGERY FORM

LEAST FUNCTION (LF) SCORE AT CONCLUSION OF SURGERY

Score		Description		Left	Right	
4	=	Normal	Fallopian Tube			
3	=	Mild Dysfunction				
2	=	Moderate Dysfunction	Fimbria			
1	=	Severe Dysfunction				
0	=	Absent or Nonfunctional	Ovary			

To calculate the LF score, add together the lowest score for the left side and the lowest score for the right side. If an ovary is absent on one side, the LF score is obtained by doubling the lowest score on the side with the ovary.

Lowest Score	Left	+	Right	=	LF Score

ENDOMETRIOSIS FERTILITY INDEX (EFI)

Historical Factors			Surgical Factors		
Factor	**Description**	**Points**	**Factor**	**Description**	**Points**
Age			LF Score		
	If age is ≤ 35 years	2		If LF Score = 7 to 8 (high score)	3
	If age is 36 to 39 years	1		If LF Score = 4 to 6 (moderate score)	2
	If age is ≥ 40 years	0		If LF Score = 1 to 3 (low score)	0
Years Infertile			AFS Endometriosis Score		
	If years infertile is ≤ 3	2		If AFS Endometriosis Lesion Score is < 16	1
	If years infertile is > 3	0		If AFS Endometriosis Lesion Score is ≥ 16	0
Prior Pregnancy			AFS Total Score		
	If there is a history of a prior pregnancy	1		If AFS total score is < 71	1
	If there is no history of prior pregnancy	0		If AFS total score is ≥ 71	0
Total Historical Factors			**Total Surgical Factors**		

EFI = TOTAL HISTORICAL FACTORS + TOTAL SURGICAL FACTORS:	Historical	+	Surgical	=	EFI Score

ESTIMATED PERCENT PREGNANT BY EFI SCORE

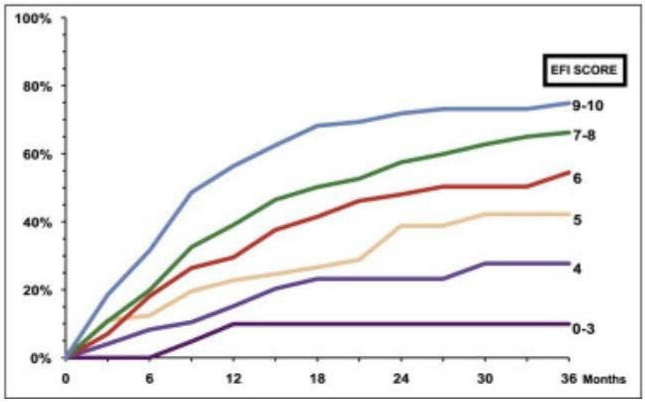
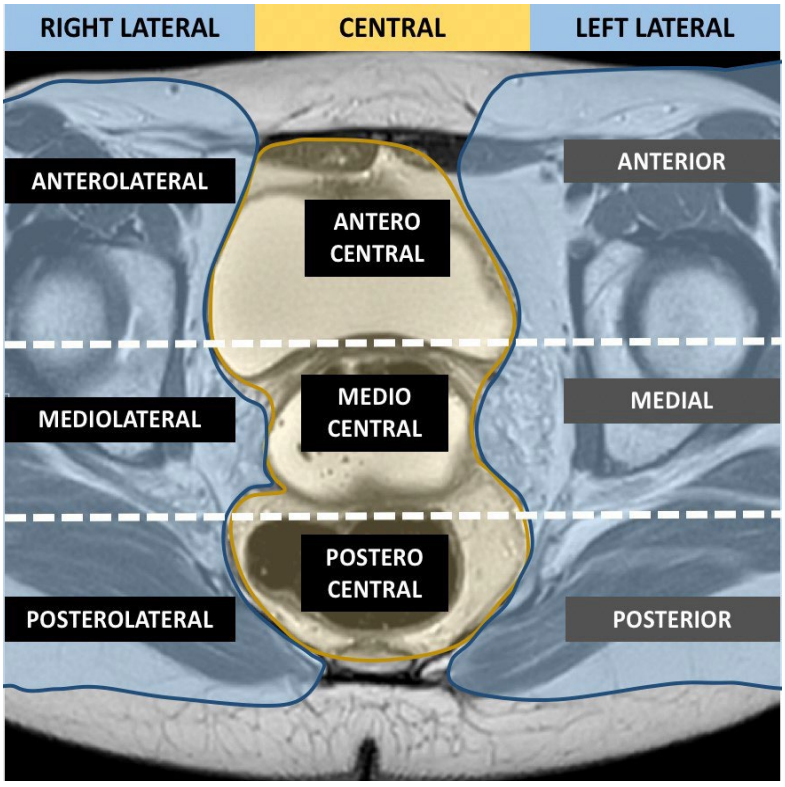


Figure 5. MRI lexicon and deep pelvic endometriosis index (dPEI) classification. Low extension (score 1 or 2), Moderate extension (score 3 or 4) and severe extension (score 5 or more) [74].



Anterolateral Distal round ligament	**Anterocentral** Proximal round ligament Bladder	**Anterolateral** Distal round ligament
Mediolateral Parametrium Ureter Uterine artery Visceral fascia and pelvic wall	**Mediocentral** Torus and proximal USL Posterior vaginal fornix Rectovaginal septum External myometrium adenomyosis	**Mediolateral** Parametrium Ureter Uterine artery Visceral fascia and pelvic wall
Posterolateral Distal USL Sacro-recto- genital septum	**Posterocentral** Rectum and rectosigmoid junction	**Posterolateral** Distal USL Sacro-recto- genital septum

Extrapelvic
Caecum- ileum- appendix
Sigmoid colon
Abdominal wall
Inguinal regions
Ureters at the level of common iliac artery

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SUPPORTING INFORMATION ON THE INTERNET

The following supporting information may be found in the online version of this article:

Figure S1 Revised American Society for Reproductive Medicine (rASRM) classification of endometriosis. Reprinted from the Revised American Society for Reproductive Medicine classification of endometriosis: 1996. *Fertil Steril* 1997; **67**: 817–821[49]. Copyright © 1997 American Society for Reproductive Medicine, with permission from Elsevier. All rights reserved.

Figure S2 #Enzian classification system for women with superficial, ovarian and deep endometriosis. Reprinted from Keckstein *et al.*[51], with permission from J. Keckstein. Copyright © 2021 The Authors. Published by John Wiley & Sons Ltd on behalf of Nordic Federation of Societies of Obstetrics and Gynecology (NFOG). Sacrouterine ligg/USL, uterosacral ligaments.

Figure S3 Ultrasound-based Endometriosis Staging System (UBESS), with sonographic features demonstrable on transvaginal ultrasound (TVS) and its prediction of level of surgical complexity. Adapted from Menakaya *et al.*[52], with permission from ISUOG. SVG, sonovaginography.

Figure S4 Endometriosis fertility index (EFI) system. This score predicts fertility outcome for women who attempt non-*in-vitro* fertilization conception following surgically documented endometriosis. Reprinted from Adamson GD, Pasta DJ. Endometriosis fertility index: the new, validated endometriosis staging system. *Fertil Steril* 2010; **94**: 1609–1615[7]. Copyright © 2010 American Society for Reproductive Medicine, with permission from Elsevier. All rights reserved. AFS, American Fertility Society.

Figure S5 Magnetic resonance imaging (MRI) lexicon and deep pelvic endometriosis index (dPEI) classification: low extension (score 1 or 2), moderate extension (score 3 or 4) or severe extension (score 5 or more). Reproduced from Rousset P, Florin M, Bharwani N, Touboul C, Monroc M, Golfier F, Nougaret S, Thomassin-Naggara I, Group E. Deep pelvic infiltrating endometriosis: MRI consensus lexicon and compartment-based approach from the ENDOVALIRM group. *Diagn Interv Imaging* 2023; **104**: 95–112[66]. Copyright © 2022 The Author(s). Published by Elsevier Masson SAS on behalf of Soci´et´e franc¸aise de radiologie. All rights reserved.

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Enhancing Hysteroscopic Surgery Safety in Hypofertile Patients through Advanced Gynaecological Ultrasound Imaging. A case example of how the imaging study optimize hysteroscopic surgery in a complex uterine pathology

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Abstract

This article explores how a gynaecological level 3 endovaginal ultrasound study can preoperatively determine the appropriate hysteroscopic surgical technique. It presents a treatment plan for a complex case involving an hypofertile patient with a distorted endometrial cavity due to multiple polyps and intramural leiomyomas. The use of the Bigatti shaver proved beneficial for delicately removing the polyps while preserving the remaining endometrium intact. However, considering the patient's desire for pregnancy, the removal of an intramural fibroid protruding into the endometrial cavity was contemplated for a subsequent operation.

The preoperative and comprehensive gynaecological ultrasound study provided reassurance regarding which areas should be treated and offered information that modified the hysteroscopic approach to a two-step surgery. This approach aimed to reduce the risks associated with post-resection adhesions and intraoperative complications.

Conventional methods of polyp removal, such as mechanical removal or bipolar electric energy, while effective for treating symptoms like menorrhagia, do not significantly reduce the risk of intrauterine adhesion formation, which could directly impact the patient's future ability to conceive. Polypectomy using hysteroscopic tissue removal devices, such as the Intrauterine Bigatti Shaver (IBS®), represents an advanced technique that minimizes the creation of adhesions. It should be considered as the primary instrument for use in hypofertile patients or those wishing to conceive postoperatively.

Key words:

Gynaecological ultrasound, Bigatti shaver technique, operative hysteroscopy, hypofertility, endometrial polyp, intramural fibroid, menorrhagia

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Case discussion

A 39-year-old patient with a history of heavy periods experienced worsening menorrhagia over the past eight months. Examination and ultrasound revealed a distorted uterine cavity due to a combination of multiple fibroids and intrauterine polyps. The patient also presented with severe microcytic anemia (haemoglobin level of 7.5 mg/dL, mean corpuscular volume (MCV) of 60.3f, and ferritin < 4.0 ng/mL) due to iron deficiency, requiring urgent intravenous (IV) iron therapy using the Ferinject® protocol as a day-case hospital admission.

While waiting for the IV iron therapy to take effect on correcting the anemia, symptomatic treatment was initiated using nonsteroidal anti-inflammatory drugs (NSAIDs) and tranexamic acid, which effectively reduced bleeding and completely stopped it within seven days. Due to the persistence of symptoms, urgent hysteroscopic surgery was deemed necessary.

After 28 days following the IV iron infusion, the patient's haemoglobin level normalized to 12.0 mg/dL, MCV increased to 74.8, and ferritin level rose to 54.3 ng/mL, allowing for the surgical procedure to proceed. The patient desires pregnancy and had cryopreserved five oocytes in the previous year. She has low anti-Müllerian hormone (AMH) levels and she is considered a low responder to ovarian stimulation.

The challenge in this case was to preserve the endometrial cavity as normal as possible to treat the menorrhagia effectively, avoid intraoperative complications, and prevent the formation of intrauterine adhesions, which could impede natural conception or successful embryo transfer in the future.

Preoperative ultrasound study

The patient has two fibroids: one subserosal fibroid located on the top left fundal part of the uterus, measuring 4-5 cm, and a second intramural fibroid situated just above the cervix's isthmus on the left side, measuring 1.8 x 1.41 x 1.59 cm. The intramural fibroid is protruding indirectly into the endometrial cavity, as depicted in images 1 and 2.

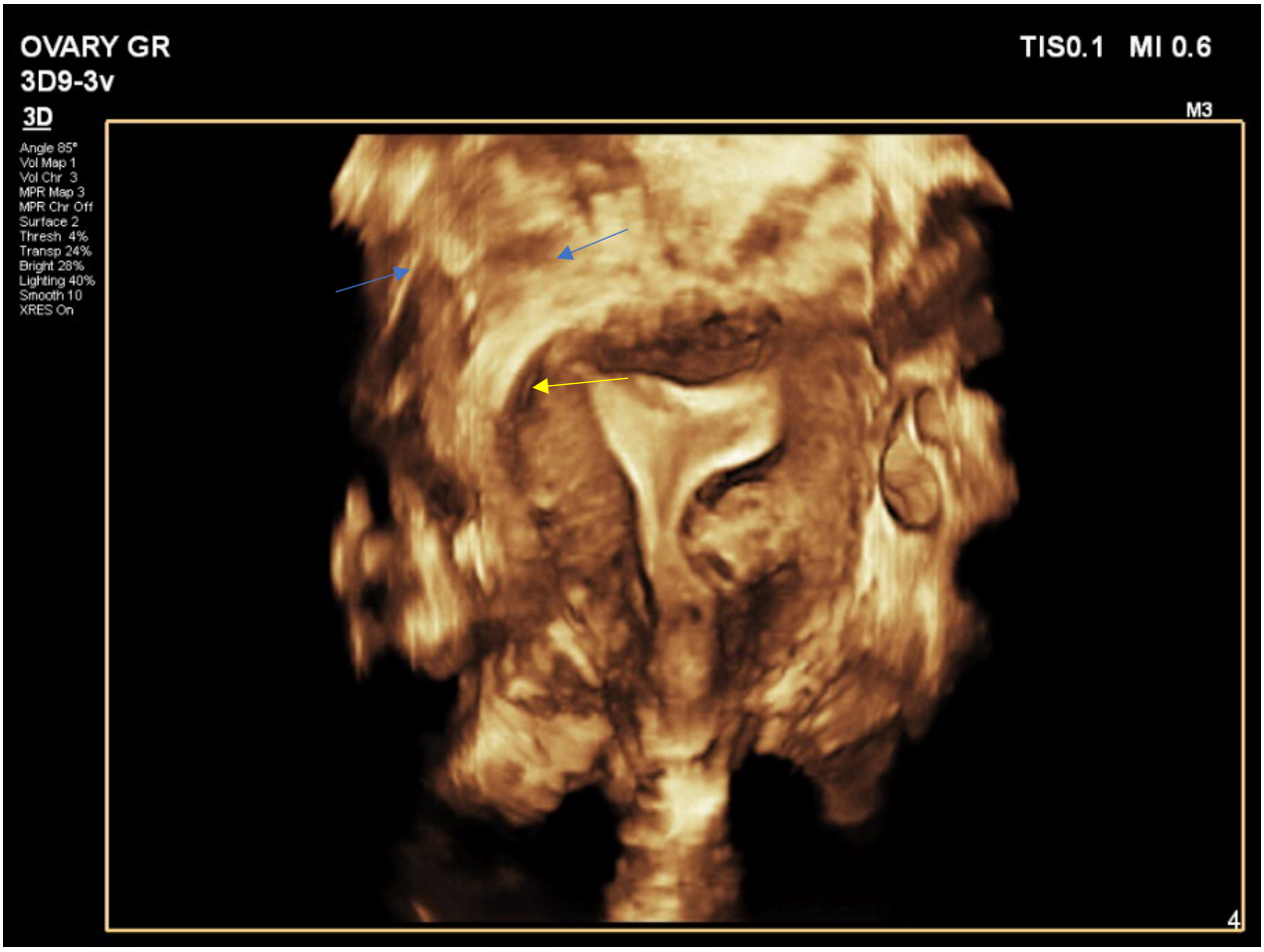

Image 1: 3D image in left rotation, showing the intramural fibroid yellow arrow, the fundal endometrial cavity is normal and the 3D slide show the ostium on both sides' blue arrows

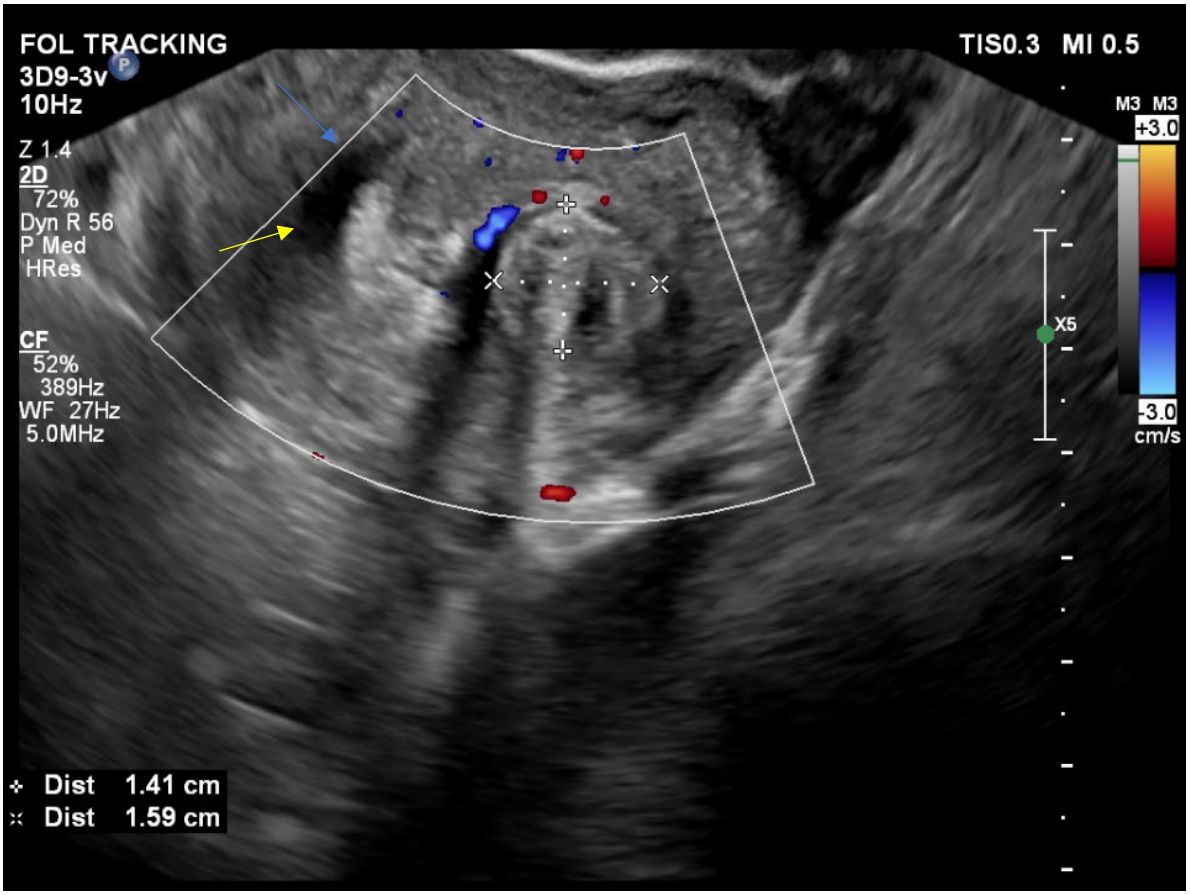

Image 2: Transverse measure / cut of the intramural fibroid note the peripheral vascularity towards the endometrium blue arrow, yellow arrow endometrium

The fundal part of the uterus showed no septum but polyps were detected. These polyps, along with the thickened endometrium, were found in three areas: one in the upper right part near the ipsilateral tubal ostium (P1), and two others, one under the left side near the ostium (P2) and one just above the endometrium covering the intramural fibroid (P3), as depicted in images 3 and 4. All polyps had superficial contact within the middle part of the cavity, touching the endometrium covering the intramural fibroid. Various imaging methods, including 2D, 3D plain mode, Flex view (ultrasound tomography mode), Colour Doppler, and Power Doppler, were used to precisely assess the location, vascularity, and relationship with the myometrium features, as shown in

images 5, 6, and 7. The serosa myometrium thickness covering the intramural fibroid measured between 0.8 and 0.7 cm.

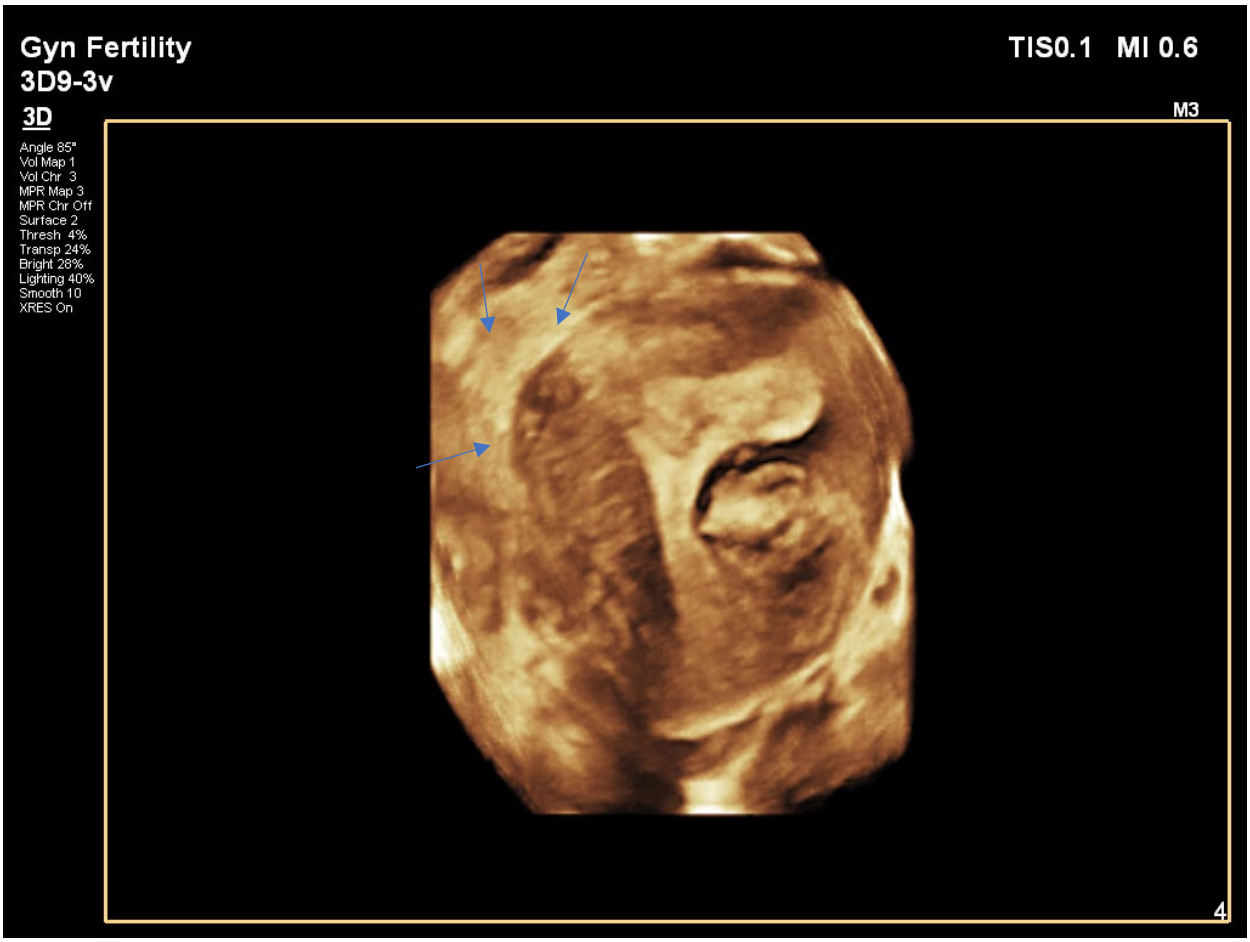

Image 3: Polyp locations on 3D mode, blue arrows: one under the right ostium presented as triangular longitudinal structure (P1), another one above the intramural fibroid (P2) a third one adjacent to top part of the isthmus from the left side (P3)

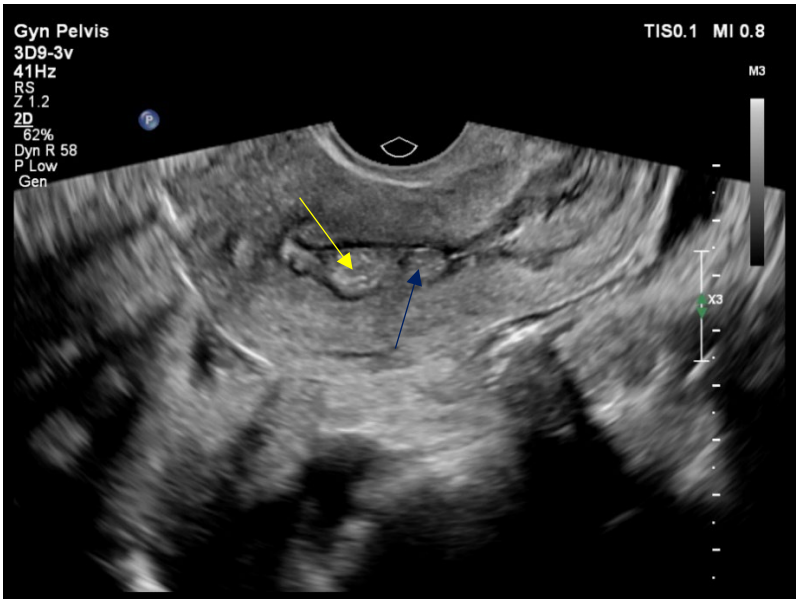

Image 4: Longitudinal view in midline, 2 parts of polyps, yellow arrow: polyp from the right(P1), and blue arrow shows polyp 3 (P3). All polyps are in contact within the middle part of the endometrial cavity.

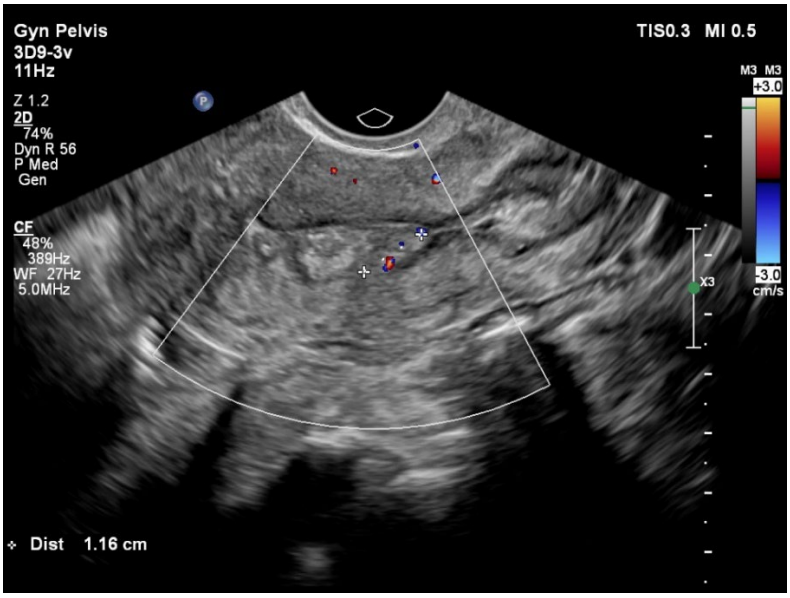

Image 5: Showing the vascular pedicle of the polyp (P3)

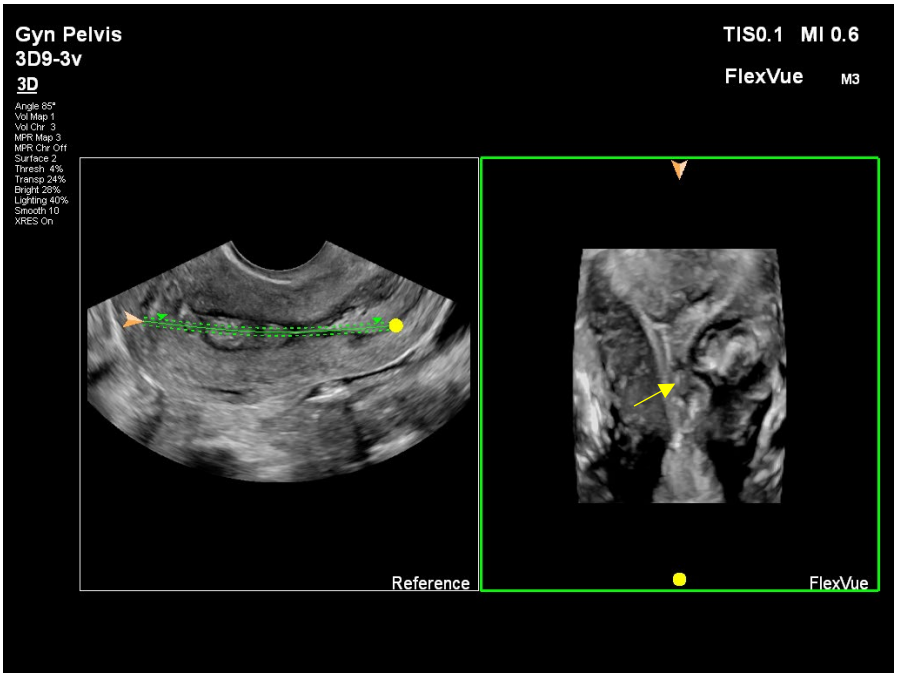

Image 6: Using ultrasound tomography mode / flexvue on Epiq Elite Phillips® machine. Selective slide from the 3D volume, is represented, and the P3 is detected with precision (yellow arrow), the 3D image is rotated to the right in order to see better the left ostium and cornual myometrium.

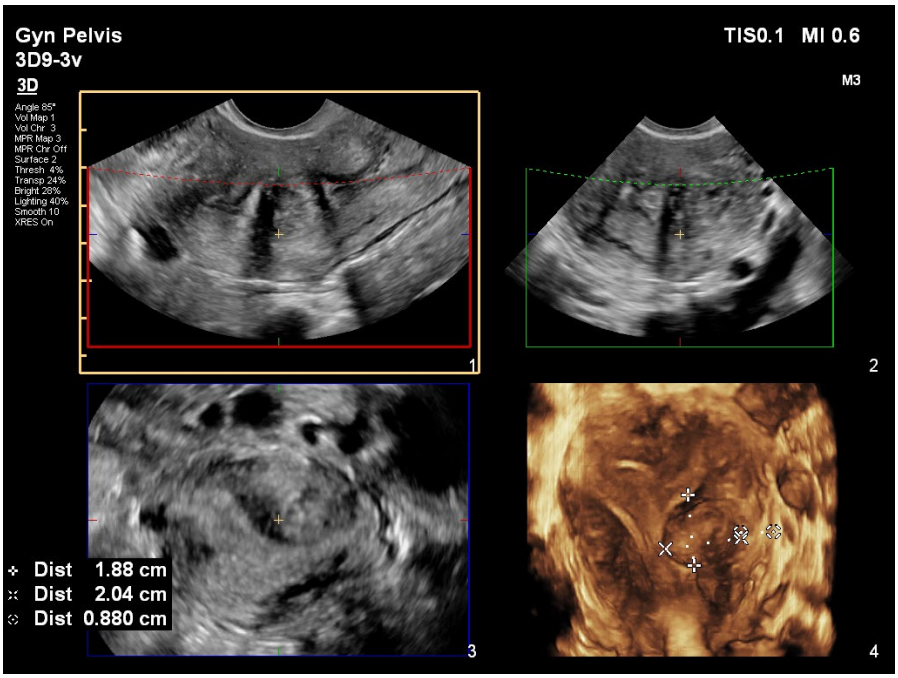

Image 7: 3D Study to assess the remaining (normal external) myometrium from the serosa assessing the operative risk and technical difficulty in case of left intramural myomectomy, the external limit was between 0.88- 0.7cm however the overall thickness of the left and right myometrium was not significantly different.

Hysteroscopic surgery

Following thorough informed consent, the patient underwent a day-case operative hysteroscopy using the Intrauterine Bigatti Shaver (IBS®). Initial images confirmed the preoperative ultrasound findings, showing all structures (thickened endometrium and polyps) in contact in the middle part of the cavity (images 8, 9, and 10). The polypectomy was successfully completed, as evidenced by images 11 and 12. The intramural fibroid caused minor modifications to the left lateral wall with thickened endometrium. Gentle shaving and "deroofing" were performed without penetrating deeply into the myometrium. Haemostasis was secured using a bipolar electrode after detecting the superficial vessel seen in the ultrasound (images 13, 14, and 15).

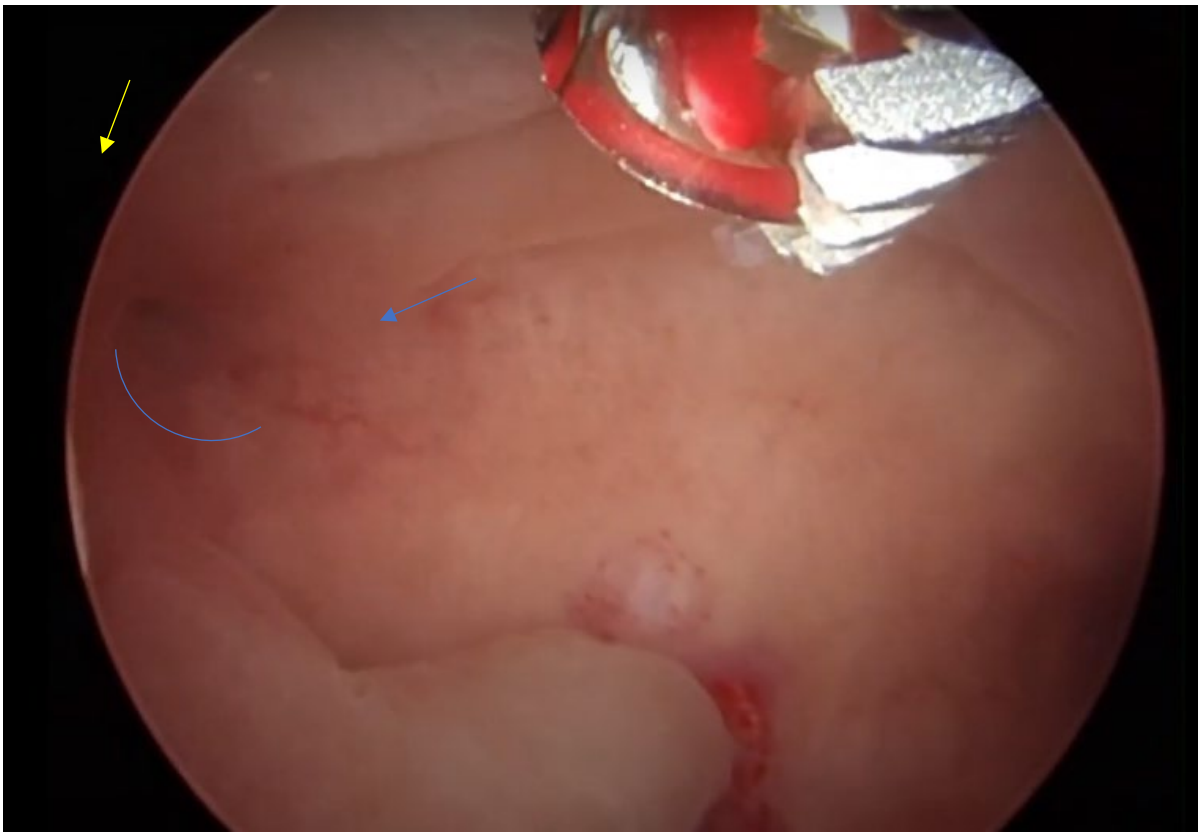

Image 8: Right ostium (yellow arrow), a longitudinal triangular polyp P1 (blue oblique line), on the top of the hysteroscopic image, the distal end of the Bigatti cutter. The blue arrow shows the imprint on the endometrium when the Bigatti blunt distal part touched the endometrial surface

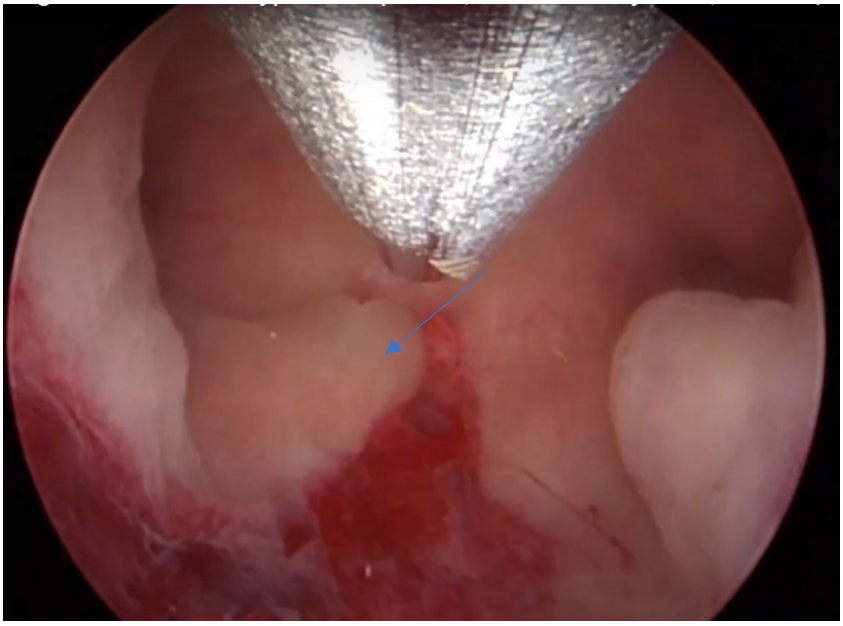

Image 9: The fundal part of the cavity in this panoramic view, both ostia seen, note the inflamed endometrium under the right polyp (P1) at the middle part of the cavity, blue arrow, as well the polyp 2 (P2) from the left side.

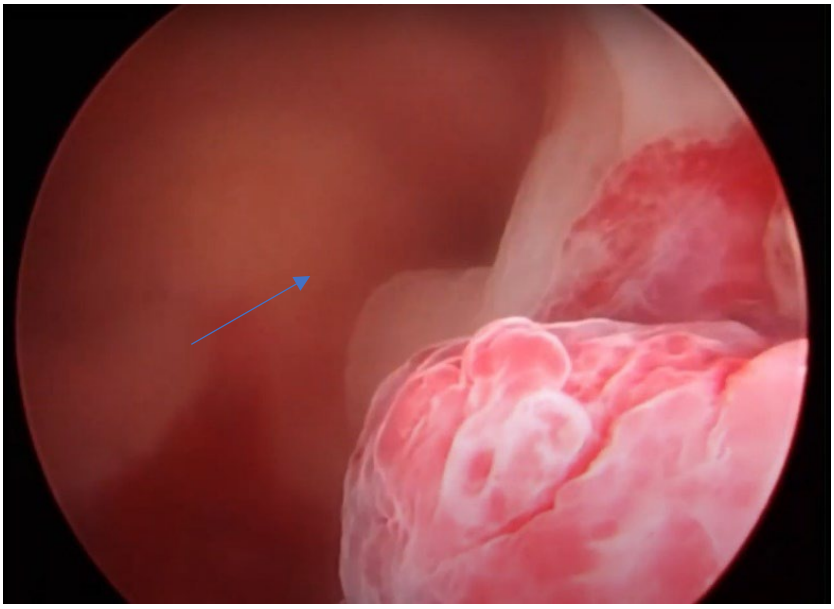

Image 10: Endometrial cavity, view of the left lateral part showing both left polyps, the P3 is the lowest and inflamed, behind is the P2 blue arrow.

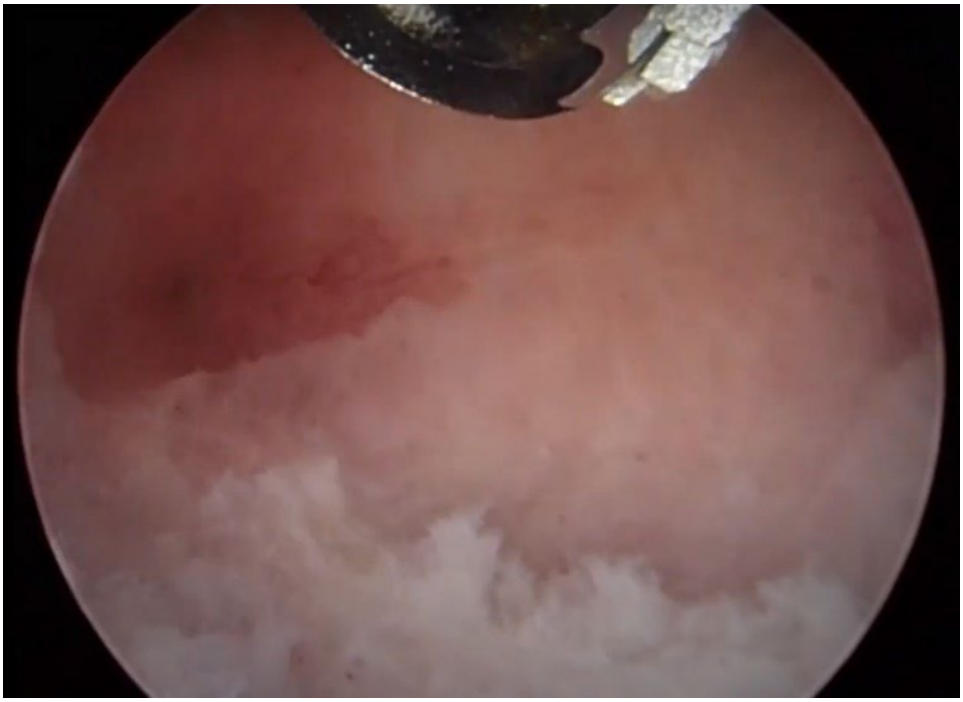

Image 11: Polypectomy completed on the right side (P1) the ostium is intact.

Image 12: Polypectomy was completed both ostia are clear and intact note that the fundal cavity is now normal in symmetry

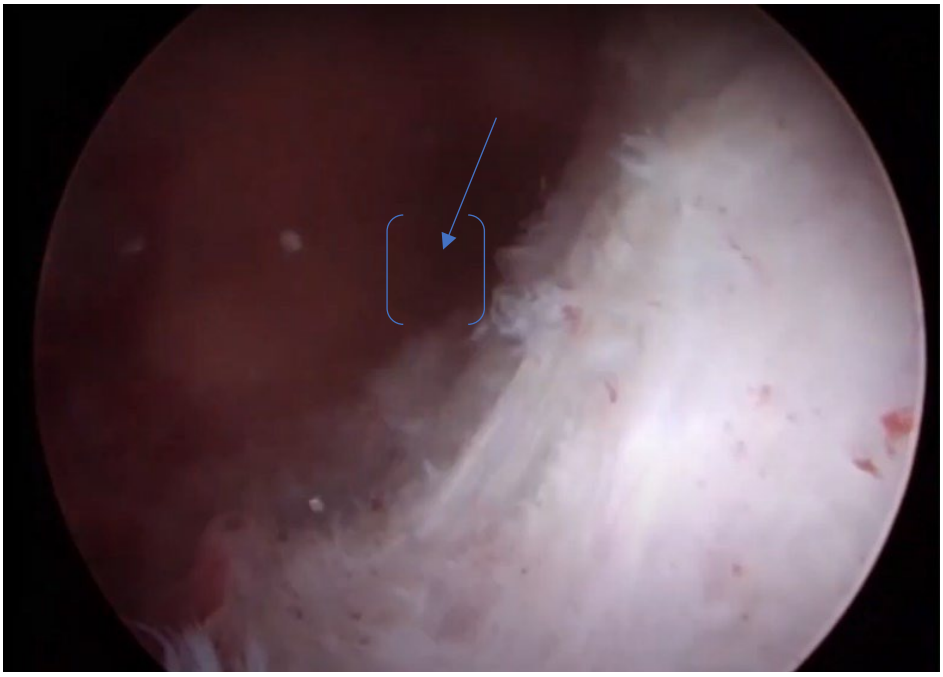

Image 13: After gentle shaving on the top part of the fibroid protuberance the area of the fibroid is seen blue arrow

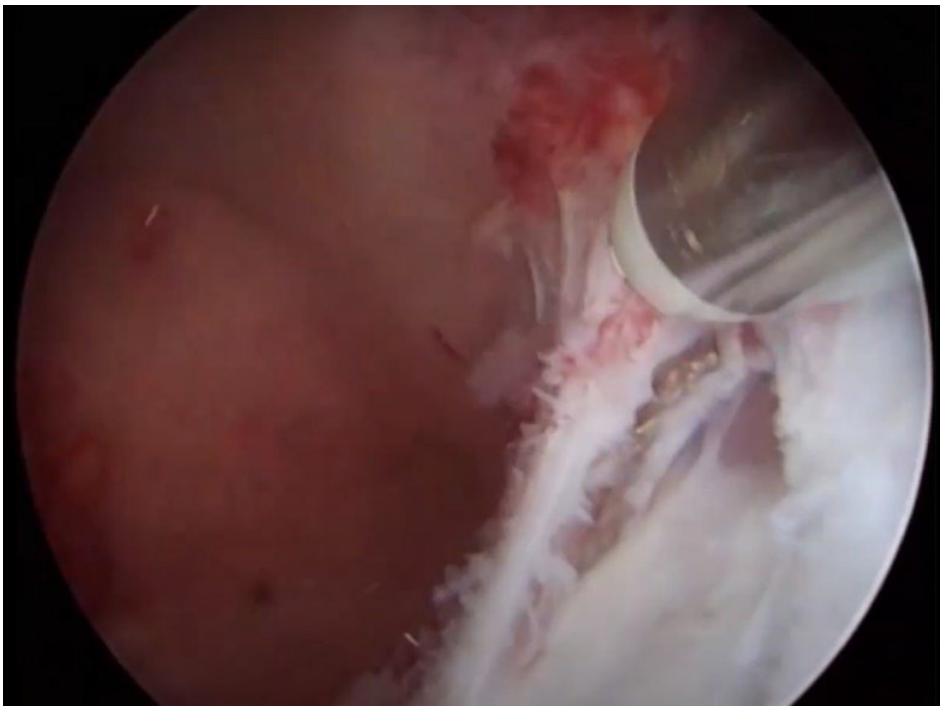

Image 14: Haemostasis and coagulation of the superficial vessel feeding the intramural fibroid using Bigatti bipolar electrode

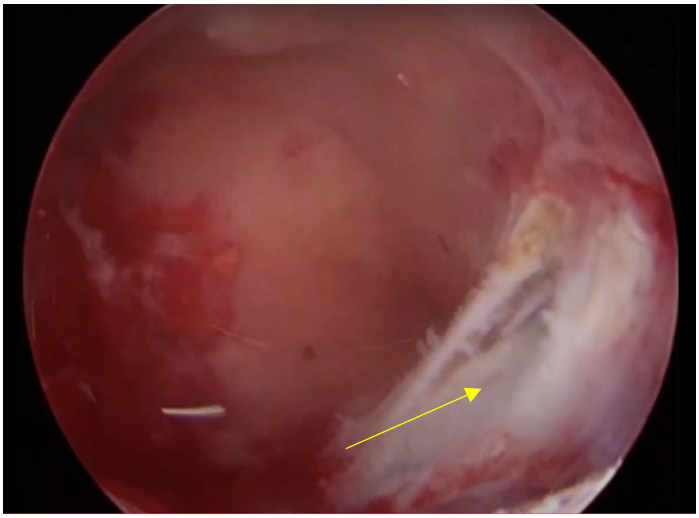

Image 15: Final result, note the deroofing imprint on the superficial part of the fibroid, yellow arrow

The patient underwent the operation during the second phase of her menstrual cycle. By the end of the procedure, the uterine cavity showed improved symmetry. Hyalobarrier® Gel was used as an additional measure to prevent the formation of intrauterine adhesions. The patient experienced a smooth recovery. The histology report confirmed the presence of submucosal segments of leiomyoma, segments of adenomatous endometrial polyp, and a section of endometrium in an advanced and partially abnormal secretory phase of the cycle. Postoperative follow-up included monthly ultrasound examinations for three months, which confirmed the maintenance of uterine cavity symmetry and the absence of polyp recurrence, as seen in the provided images. Further follow-up with endovaginal ultrasound studies and office hysteroscopy is scheduled in the near future. Recent ultrasound evaluation shows after three months

postoperatively an improvement of the intrauterine cavity as shown in image 16. The patient, who is now in a new relationship, intends to attempt natural conception if possible. Long-term fertility assessment has been agreed upon.

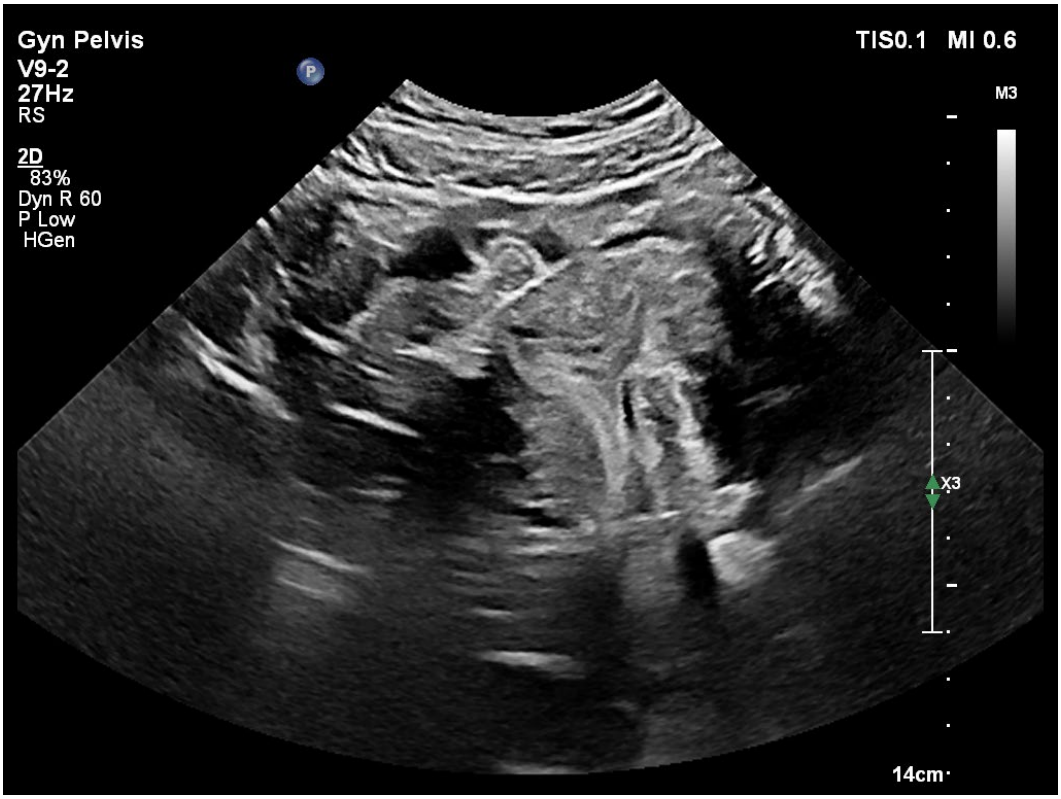

Image 16: Pelvic ultrasound image of the internal uterine cavity with symmetry above the cervical isthmus

Discussion

Ultrasound assessments are crucial for diagnosing medical conditions or preparing for surgery, ensuring procedures are performed under optimal conditions. However, the proficiency of gynecologists in ultrasound varies widely, both within and between European countries. The European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) recognized this lack

of standardization in training requirements for ultrasound practitioners across Europe and different medical specialties.

To address this issue, the EFSUMB introduced the "Minimum Training Requirements for the Practice of Medical Ultrasound in Europe" in 2002, with the latest guidelines specifically for gynaecological ultrasound training outlined in 2006 [1] . These guidelines establish three levels of minimum training and competencies for ultrasound practitioners, each accompanied by detailed syllabi and guidelines covering practical experience, theoretical knowledge, and technical skills assessment, **see table 1**.

Despite the existence of these guidelines since 2006, awareness among gynaecologists remains low, and few have completed all three training tiers. Level 3 competency is critical for achieving optimal imaging, precise measurements, and accurate preoperative assessments, including lesion characterization, margin delineation, volume determination, and assessment of vascularity. Utilizing multiple imaging modalities, such as 2D and 3D ultrasound, alongside vascular studies, supports therapeutic decision-making and facilitates informed patient consent by providing comprehensive information.

Failing to conduct a thorough preoperative ultrasound assessment may lead to unexpected complications during surgery or suboptimal surgical outcomes. Therefore, the selection of appropriate instruments and techniques relies heavily on the quality of preoperative ultrasound assessments. In cases where only basic 2D or 3D studies are conducted, there is a higher risk of encountering unforeseen challenges during surgery. Access to specialized instruments, like the Bigatti

shaver, may also be limited, further emphasizing the importance of thorough preoperative planning and preparation.

Reduced fertility following hysteroscopic surgery can result from the development of intrauterine adhesions (IUAs) [2,3]. While hysteroscopic procedures effectively address various uterine issues, they can inadvertently harm the delicate endometrial lining, leading to adhesion formation within the uterine cavity. These adhesions disrupt the normal structure of the uterus, hindering implantation and affecting blood flow to the endometrium. Consequently, individuals may face challenges in conceiving or maintaining a pregnancy after surgery. The severity of fertility issues after hysteroscopic surgery depends on factors like the extent of adhesion formation and the individual's reproductive goals. Managing reduced fertility often involves a multidisciplinary approach, including hysteroscopic assessment and adhesiolysis to remove adhesions, hormonal therapy to promote endometrial regeneration, and assisted reproductive techniques to enhance the chances of conception. In complex cases, especially in patients with known low ovarian reserve and complicated intrauterine anatomy, efforts should be made to minimize the risk of intrauterine adhesions as much as possible.

In the case example, the polyps were located in "mirroring locations," and aggressive removal with a bipolar Transcervical Resection of Endometrium (TCRE) instrument could potentially lead to intrauterine adhesions, causing the endometrial surfaces of opposite sites to become stuck together over time. The thickened endometrium and polyp were positioned just under the ostium opening, making it challenging to remove the entire lesion without touching the

ostium and causing thermal injury, even with a smaller caliber TCRE loop.

The Bigatti system offers advantages in this situation [4,5,6]. Its automated suction feature allows the lesion destined for removal to be enclosed within the probe, preventing mechanical injury to external adjacent tissues. Additionally, the cervical dilation required for introducing the Bigatti probe (19 French IBS) is smaller compared to standard TCRE scopes. Standard resectoscopes vary between 26 and 24 French but nowadays we have 15 French resectoscope, reducing the risk of cervical trauma, which is particularly important for patients with fertility issues. The Bigatti system does not use thermal energy, minimizing thermal spread effects on the remaining endometrium and reducing the time needed to complete the polypectomy. Removal of polyp was necessary [7] to treat menorrhagia and irregular cycles but as well in order to restore a synchronized endometrium reducing local inflammation and thickness irregularities aiming to increase the chances for spontaneous conception or enhanced embryo transfer.

Regarding the intramural fibroid, the hysteroscopic view did not show significant intrauterine occupation. Thus, the decision was made to shave the endometrium above the intramural fibroid, between polyps P2 and P3. The appearance of the endometrium in this area was inflamed and altered. Hemostasis was ensured at the end of the operation.

Removing the superficial fibers of the intramural fibroid (deroofing) could facilitate future management if the fibroid continues to grow, potentially allowing it to protrude into the cavity and enabling Transcervical Resection of

Fibroid (TCRF). However, postoperative follow-up is essential to assess anatomy stability, and complete or partial fibroid resection, combined with areas of endometrial polypectomy, may increase the risk of intrauterine adhesions due to a larger surface for re-epithelialization healing.

For this patient, achieving symmetry and proper reepithelialization of the endometrial cavity are critical for future pregnancy outcomes. Close monitoring and personalized treatment strategies are essential to address hypofertility effectively and improve reproductive outcomes for affected individual. These cases take time lot of effort from the patient and dedicated medical care.

Post-hysteroscopic resection intrauterine adhesions (IUAs) refer to the adhesions that may develop within the uterine cavity following a hysteroscopic surgical procedure. These adhesions, can result from trauma to the endometrial lining during the surgery.

The severity of IUAs can vary [8,9,10], ranging from mild adhesions that may cause minimal symptoms to severe cases leading to infertility or recurrent miscarriages. Management of post-hysteroscopic IUAs typically involves a combination of surgical intervention and adhesion prevention strategies [8,10].

Surgical techniques such as adhesiolysis are employed to remove the adhesions and restore the normal anatomy of the uterine cavity. Better results in regards fertility would be predicted if there is no creation of IUAs in comparison to patients who had IUAs of some degree and had to be treated with adhesiolysis.

There is a scarcity of articles demonstrating the importance of advanced imaging techniques preoperatively [11]. Recent guidelines

from the International Society for Gynaecological Endoscopy (ISGE) emphasize the significance of thorough ultrasound assessment of the intrauterine cavity before any surgical intervention, including the removal of submucosal fibroids [12]. Similarly, close postoperative monitoring and long-term follow-up are crucial in managing post-hysteroscopic intrauterine adhesions (IUAs) to ensure optimal outcomes, especially for patients aiming to conceive. The challenge for hysteroscopists is to minimize the likelihood of such adhesion formation. Finally, the value of office hysteroscopy, when accessible to the patient, serves as an additional tool for objectively evaluating the intrauterine cavity, confirming desired endometrial healing, and detecting IUA recurrence.

Conclusion

The preoperative and complete gynaecological ultrasound study ideally of level 3 reassured which areas should be treated and provided information which modified the hysteroscopic approach to a 2-step surgery. If the patient were not considering future pregnancy, a more aggressive approach, involving fibroid resection, would have been pursued. However, in this instance appropriate gynaecological ultrasound advanced imaging study, the constrained external boundary of normal myometrium surrounding the fibroid, as well as the peripheral vascularity, posed significant challenges that warranted careful consideration, rendering the task notably demanding. The use of the Bigatti shaver was deemed less aggressive and less prone to causing adhesions compared to conventional resection techniques (TCRE) for polyps and / or fibroids. It is imperative to thoroughly explain our instruments and techniques to patients, allowing them to actively participate in therapeutic decision-making. This

process necessitates comprehensive informed consent and an honest discussion regarding the limitations of the techniques, regardless of the expertise level of the hysteroscopist.

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Table 1: EFSUMB gynecological ultrasound competence levels

Level 1 practice requires a practitioner to do the following:

• Perform common examinations safely and accurately

• Recognize and differentiate normal anatomy and pathology

• Diagnose common abnormalities within certain organ systems

• Recognize when referral for a second opinion is indicated

It was judged that at this level, training would be acquired during conventional postgraduate specialist training programs.

Level 2 practice would require spending a period of subspeciality training and the ability to do the following:

• Accept and manage referrals from level 1 practitioners

• Recognize and correctly diagnose almost all pathology within the relevant organ system

• Perform basic, noncomplex ultrasound-guided invasive procedures

• Teach ultrasound to trainees and to level 1 practitioners

• Conduct some research in ultrasound

At level 3, a practitioner would practice at an expert level, performing complex examinations and ultrasound-guided interventions as well as being involved in teaching and research in ultrasound.

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Polyps' treatment with the 24Fr. Intrauterine BIGATTI Shaver (IBS®): A 1000 patients' retrospective descriptive analysis

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Abstract

Objective: To evaluate the IBS® safety and efficacy as hysteroscopic tissue mechanical removal system for endometrial polyps' treatment.

Methods: This retrospective cohort study included 1000 patients with a diagnosis of endometrial polyps carried out at Renji hospital affiliated to Shanghai Jiao Tong University between June 2019 and January 2021. The diagnosis of endometrial polyp was suspected at 2D transvaginal ultrasound and confirmed by a diagnostic hysteroscopy with the Campo Trophyscope®. Only patients with polyps larger than 1 cm were included in the study. All patients were treated with the 24Fr. IBS®. The recurrence rate was evaluated by 2D ultrasound after 12-month from the operation and confirmed by diagnostic and operative hysteroscopy.

Results: Patients' mean age was 47.8 years (range 22-86) with a mean childbirth rate of 1.2 (range 0-7). 284 (28.4%) patients were postmenopausal, 324 (32.4%) patients had abnormal

uterine bleeding and 266 (26.6%) infertility. The mean operation time was 12.5 min (range 1-55 min) with a mean fluid deficit of 146.8 mL (range 0-1500 mL). Four complications were reported of which three (0.3%) were intraoperative bleedings and one (0.1%) was a cervical laceration during dilatation. No major complication, such as fluid overload or uterine perforation occurred. Only 3 (0.3%) cases were diagnosed of polyps' recurrence by ultrasound and confirmed by diagnostic hysteroscopy at a 12-month follow up and underwent to a second operative procedure.

Conclusion: This study shows that polyp's removal with the IBS® is a very safe and precise hysteroscopic treatment. The additional removal of the functional endometrial layer does not result in adhesion formation or post operative complications but in a very low recurrence rate of polyps at 12-month follow-up.

Key words: Intrauterine BIGATTI shaver, IBS®,Endometrial polyps, Operative hysteroscopy, Polypectomy.

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Introduction

Endometrial polyps are the most common cause of abnormal uterine bleeding, and their removal is essential due to their association with infertility and potential malignant transformation [1]. Diagnostic hysteroscopy has shown that 16.5–26.5% of women with unexplained infertility are diagnosed with endometrial polyps [2]. The estimated incidence of malignancy in these polyps ranges from 0.5 to 4.8% [3]. Currently, hysteroscopy is considered the gold standard procedure for treating polyps due to its direct visualization and high accuracy [4]. The bipolar resectoscope, despite its high complication rate, remains the most widely used device for operative hysteroscopy [5-8].

There has been an important technical improvement for polyp's treatment with the development of hysteroscopic mechanical tissue removal systems [9]. The IBS® was specifically designed to enhance efficacy and to reduce the complication rate associated with conventional resectoscopy. By enabling simultaneous removal of tissue chips during resection, the IBS® technique provides clear visualization throughout the entire procedure and shortens the learning curve for surgeons [10,11]. This study represents the first large cohort analysis to evaluate the IBS® technique safety and efficacy for the treatment of endometrial polyps.

Materials and methods

Study Design

This retrospective observational cohort analysis was conducted from June 2019 to January 2021, at the Sino European Life Expert Centre "SELEC" of RenjI Hospital in Shanghai. Helsinki declaration and Renji Hospital Guidelines were carefully followed in this study [12]. Due to the observational nature of the research, no need of the moral committee approval was required. All patients' data were anonymized.

Patients

1355 patients undergoing an IBS® hysteroscopic procedure from June 2019 to January 2021 were included in the present study. Of this group, 27 (2.0%) with submucosal myomas, 15 (1.1%) with adhesions, 4 (0.1%) with placental remnants, 73 (5.4%) with atypical hyperplasia, 21 (1.5%) with uterine malformations and T-shaped like uterus and 5 (0.4%) patients with other indications for a total of 145 patients were excluded from this study. 210 patients with the diagnosis of benign polyp were lost at follow-up after surgery and therefore were excluded. The histopathological diagnosis of polyp or polypoid endometrium was confirmed by two different pathologists [1].A total of 1000 patients were included in our survey, including 11 patients with polyp recurrence who underwent hysteroscopic polypectomy before. All patients completed a 12-month, follow-up survey. Personal medical history, resection time, operation time, and complications were recorded. For total operation time we considered the time of the whole procedure. On the other hand, we considered the resection time as the time from the view of the shaver tip inside the uterine cavity until the end of resection.

Equipment

All polypectomies were performed with the 24Fr. IBS® (Karl Storz SE & Co. KG Tuttlingen Germany). A detailed description of the equipment was presented in our previous publication [10]. The diagnostic and office hysteroscopies were performed with the Campo Trophy scope® (Karl Storz SE & Co. KG Tuttlingen Germany).

Surgical Procedure

All operations were performed under general anaesthesia, and a standard gynaecological set up was used in all operating theatres. After cervical dilatation up to number 8.5 mm of Hegar, the IBS® 24Fr. optics was inserted inside the uterine cavity. Once the pathological site was exposed and visualized, the rigid shaving system connected to the motor drive unit was inserted inside the operative channel and the polyp's resection could begin. The rotating oscillating movements of the inner blade of the shaving system cut the tissue allowing specimen aspiration for histology. We used an IBS® oscillating rotation power of 2100 RPM with an aspiration flow of 250ml/min (Fig.1-2). Polyps were removed starting from their edge until reaching their base. In all patients the polyp's removal was extended to all the functional endometrial layer to improve both symptom relief and pregnancy outcome. All treatments were performed by expert surgeons with similar educational background and surgical skill in the IBS® use. Both 19Fr. and 15 Fr. IBS® were not yet available in China during our study and therefore general anaesthesia, due to the large diameter of the 24 Fr. IBS® optics, was necessary.

Data Collection and Follow-up

Dr Xia Yin and Xiaoshi Liu retrospectively collected all data from the patients' clinical charts (recorded at time of polypectomy). All patients completed a 12-month follow-up survey and were contacted by telephone to evaluate patients' symptom improvements and to retrieve missing information. All patients regularly received a transvaginal ultrasound and were seen at periodic gynaecological office examination every six months to assess polyp recurrence.

Results

Patient cohort

From June 2019 to January 2021, 1355, patients underwent IBS® hysteroscopic procedures at the Sino European Life Expert Centre, RenJi Hospital of Shanghai. Patients were included in the study if two pathologists confirmed the histological diagnosis of polyp or polypoid endometrium. Among this group, 27 patients (2.0%) had submucous myomas, 15 patients (1.1%) had adhesions, 4 patients (0.1%) had placental remnants, 73

patients (5.4%) had atypical hyperplasia, 21 patients (1.5%) had uterine malformations and T-shaped uterus, and 5 patients (0.4%) had other indications for a total of 145 exclusions from the study. Additionally, 210 patients diagnosed with benign polyp were lost to follow-up after surgery and were therefore excluded from this study. Finally, a total of 1000 patients were included in our survey. All the patients underwent transvaginal ultrasound followed by diagnostic hysteroscopy with Campo Trophy scope® before the Operative Hysteroscopy. Polyps larger than 1 cm were included In the study as polyps with a lower diameter were directly removed during the office procedure. Eleven patients had undergone hysteroscopic polypectomy before our IBS® operation, and polyp recurrence was found during their follow-up. A total of 1583 endometrial polyps were completely removed during operative hysteroscopy (Fig.3). During each surgical procedure, one to five polyps were removed. The basic clinical characteristics of the 1000 patients are summarized in Table1.

The median age of patients undergoing treatment was 47.8 years (ranging from 22 to 86 years) and mean childbirth was 1.2 (range 0-7). There were 284 (28.4%) women in the postmenopausal state, with a mean age of 63.2 years. In 324 (32.4%) patients and in 266 (26.6%) the indication for operative hysteroscopy was abnormal uterine bleeding and infertility respectively. For 963 patients (96.3%) the histopathological diagnosis was endometrial polyp, while for 37 cases (3.7%) was an association of polyp and hyperplastic endometrium.

Safety and efficacy

The operation time was recorded for all patients, with a mean duration of 12.5 minutes (ranging from 1 to 55 minutes). The mean resection time was 3.5 minutes (ranging from 0.9 to 30 minutes). In this study, the mean of fluid deficit was 146.8 ml (Table 2). A total of four complications (0.4%) were reported. Three cases involved intraoperative bleeding, and one case involved cervical laceration. Intraoperative bleeding was treated with administration of intravenous oxytocin and with the aid of a bipolar probe introduced inside the strait operative channel of the shaver optics during the procedure. No major complications such as fluid overload or uterine perforation were reported. 211 (21.1%) women were treated with oral contraceptives or progesterone for 3-6 cycles to prevent recurrence after polypectomy. During the 6 months follow-up, 39 patients were still symptomatic without abnormal transvaginal ultrasound findings. After completing a median 12-month follow-up, only 3 (0.3%) patients were symptomatic and had a polyp recurrence suspected at ultrasound and confirmed by diagnostic hysteroscopy. Eleven patients who had previous postoperative polyp recurrence did not experience recurrence again after the IBS® treatment. There were no late complications like intrauterine adhesions or hypomenorrhea. The three patients underwent to a second IBS® operative procedure to remove the recurrent polyp.

Discussion

Endometrial polyps account for about 80% of endometrial pathology. They represent a focal or diffuse glands and stroma overgrowth of the endometrial functional layer. [13,14]. They can be sessile or pedunculated [13] with a size that ranges from a few millimetres up to several centimetres. Abnormal uterine bleeding is the most common symptom and occurs in 68% of premenopausal and postmenopausal women with endometrial polyps [14,15]. Most endometrial polyps are benign with a possible malignant transformation in 3.2 to 6.7% of cases [16-17]. Hysteroscopic polypectomy using the mechanical tissue removal systems has been shown to be a fast, safe, and well-tolerated technique, with a very short learning curve [9,19] as previously reported by Bigatti et al [20]. Until now, very few large-scale cohort studies to evaluate this procedure have been performed. The primary endpoint of this study was to assess the IBS® (Karl Storz SE & Co. KG Tuttlingen Germany) safety and efficacy for polypectomy in a retrospective cohort study on a large number of patients. 1000 procedures were included in our study. All polyps were successfully excised with a mean operation time of 12.5 minutes (range 1 from 55 min) and a mean resection time of 3.5 minutes (range 0.9-30 min). Compared to the bipolar resectoscope, surgery was not interrupted by tissue chips removal, which explains the very short operation and resection time. Only normal saline was used with no fluid overload syndrome. Despite uterine perforation is the most common complication at hysteroscopy [21,22,23] none of this damage was reported in our retrospective cohort study. All IBS® procedures were performed under visual control as tissue chips were removed at the same time as resection. The high perforation rate of bipolar resectoscopy is mainly due to the reduced visibility induced by the tissue chips that stay inside the uterine cavity after resection. In addition, the in and out movements performed to remove the tissue chips from the uterine cavity after resection to clear the impaired visibility, increase the overall surgical time with a high risk of fluid overload syndrome, gas embolism and cervical laceration [5]. In our study we reported only 3 (0.3%) cases of intraoperative bleeding, which were all solved with the use of the bipolar probe. The IBS® has already proved to be a valid alternative of bipolar resectoscope. This benefit is confirmed by a better endometrial layer healing process with a lower risk of uterine rupture and an improved fertility outcome [24-25]. According to several studies, the endometrial polyp recurrence rate ranges from 2.5 percent to 43.6 percent, depending on the length of follow-up and the size of the polyps [27,28]. In our study we have reported an improvement regarding AUB symptoms after polypectomy. Only 3 (0.3%) patients experienced recurrence, requiring further hysteroscopic evaluation, at the 12-month follow-up. 11 patients in our cohort underwent hysteroscopic polypectomy before and found polyp recurrence during their follow-up but none of them experienced recurrence after IBS®-assisted hysteroscopic polypectomy. One possible explanation of

this low recurrence rate could be the concomitant removal of most of the functional endometrial layer in fertility age patients. Only 28.4% patients in our cohort were postmenopausal therefore reducing the risk of bias. Additionally, the absence of patients undergoing hormone replacement therapy in our study could also contribute to the lower recurrence rate. No postoperative adhesions or even Asherman syndrome was reported at follow up as the IBS® action did not involve the basal endometrial layer. All successfully treated cases experienced normal cycles after operative hysteroscopy with the Shaver technique. At present our study is the largest population-based cohort study to evaluate both efficacy and safety of the Shaver technique in case of polypectomy. The findings of this study confirm the validity of the IBS® as a safe and successful method for polyps' removal. The findings of very low recurrence rate together with the very low complication rate and the short learning curve make this technique as the gold standard procedure in case of endometrial polyps' treatment.

Author contributions

Conceptualization: RC and GB. Data collection: XY, SZ and JS. Data analysis: XY and XSL. Data management: XY, XSL, AMZ, YW and WD. Manuscript draft: XY and XSL. Manuscript revision and review: YX, XSL and GB. All authors read and approved the final version of the manuscript.

Conflicts of interest

Dr G. Bigatti is a consultant for Karl Storz SE & Co KG Tuttlingen, Germany, and a developer of the IBS® device reports personal fees from Karl Storz SE & Co KG Tuttlingen, Germany outside the submitted work. Dr R. Campo is a consultant for Karl Storz SE & Co KG Tuttlingen, Germany, and a developer of the Campo Trophy Scope® reports personal fees from Karl Storz SE & Co KG outside the submitted work. No support from the financial industry was received for this study.

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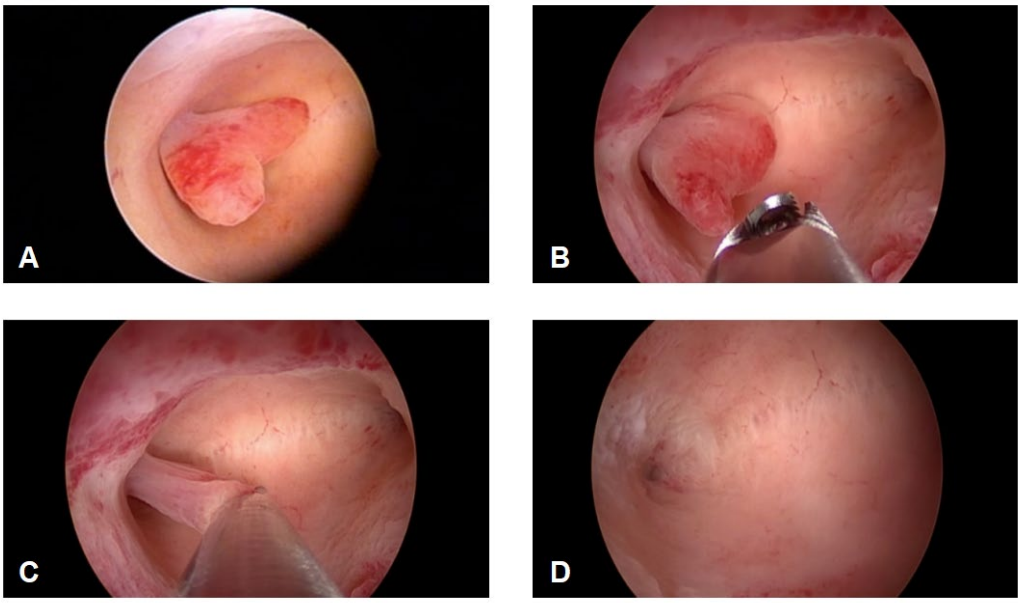
Figure:

Figure 1: IBS® resection of an endometrial pedunculated polyp. **A** Before; **B**, **C** During; **D** After IBS® treatment, respectively. The polyp is completely excised with respect of the surrounding healthy endometrium.



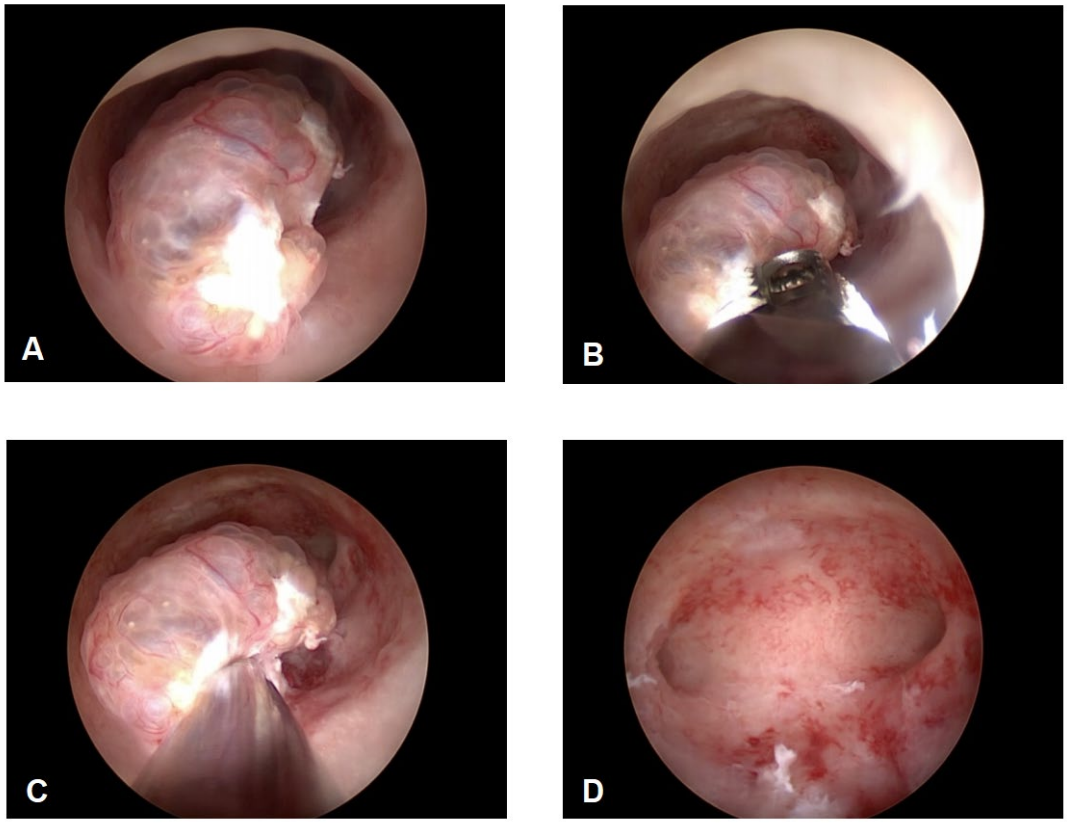


Figure 2: IBS® resection of an endometrial cystic polyp. **A** Before; **B**, **C** During; **D** After IBS® treatment, respectively.

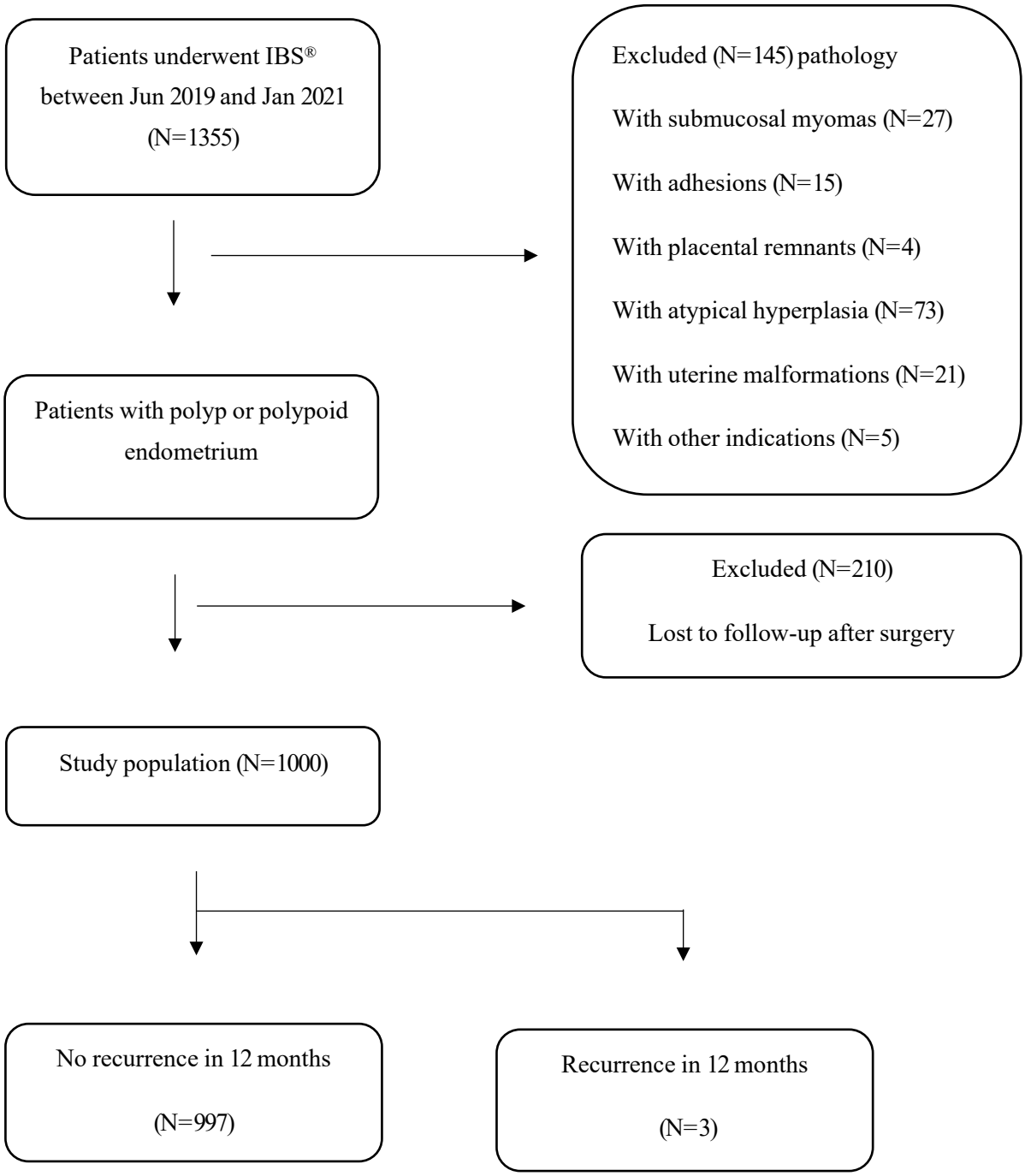


Figure 3: The enrolment process

Tables:

Characteristic	Patients[a]
Total Number	1000
Age	47.8 (22-86)
Childbirth	1.2 (0-7)
Menopausal state	284 (28.4%)
AUB	324 (32.4%)
Infertility	266 (26.6%)
Transvaginal ultrasound finding	
Abnormal	924 (92.4%)
Normal	76 (7.6%)
Histopathology	
Endometrial polyps	963 (96.3%)
Polyps with hyperplasia	37 (3.7%)

(a): Values are given as mean (SD) or No. (%)

Table 1 Characteristics of the 1000 patients treated with the 24Fr. IBS®.

Resection time (min)	3.5 (0.9-30) [a]
Total time (min)	12.5 (1-55)
Fluid deficit (ml)	146.8 (0-1500)
Complications (n=4)	
Bleeding	3 (0.3%)
Cervix laceration	1 (0.1%)
Fluid overload	0
Uterine perforation	0

(a): Values are given as mean (range) or No. (%).

Table 2 Surgical procedures and complications in patients treated with the 24 Fr. IBS

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Postmenopausal Endometriosis Presenting with Left Hydronephrosis and Terminal Renal Loss (Case report)

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Abstract

Introduction: Endometriosis after menopause, which affects 2-5% of women, is difficult to diagnose and treat, largely due to the lack of non-invasive diagnostic tools, absence of classic menstrual symptoms, and awareness[1]. It is often diagnosed in women of reproductive age with characteristic symptoms of dysmenorrhea, menorrhagia, and infertility. The absence of these symptoms poses unique diagnostic difficulties when encountered in postmenopausal women. Deep endometriosis (DE) describes the invasion of lesions exceeding 5 mm. Delayed surgical intervention of DE of the urinary tract may result in devastating consequences, including hydronephrosis and kidney loss.

Case: A 61-year-old G2P2 postmenopausal woman presented to the emergency department for acute left lower quadrant and flank pain. The patient had a history of dyspareunia, endometriosis, and use of vaginal estrogen cream. Abdominal imaging showed a 4.2 x 3 cm pelvic mass, left hydronephrosis, and ipsilateral loss of kidney function. Intraoperative findings included DE from the left pelvic sidewall to the space of Yabuki encompassing the distal left ureter. The patient underwent a total laparoscopic hysterectomy, bilateral salpingo-oophorectomy, excision of endometriosis with ligation and excision of the distal ureteral

mass, cystoscopy, and laparoscopic left nephroureterectomy with the Minimally Invasive Gynecologic Surgery service and Urology.

Conclusion: The absence of characteristic symptoms of endometriosis increases the risk of delayed diagnosis and surgical intervention in postmenopausal women. Our case displays how DE can present in a non-traditional population, identifies exogenous estrogen use as a potential risk factor, highlights the surgical importance of the Yabuki space, and addresses gaps in Sampson's theory of pathogenesis.

Key words: Endometriosis, HRT, Hydronephrosis, Laparoscopy, Management, Postmenopausal, Ureter

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Introduction

Endometriosis is a prevalent condition affecting approximately 10% of reproductive age women[2]. It is defined by ectopic endometrial-like tissue outside the uterus[3]. Yet, the challenge posed by this condition is not confined to this demographic. Notably, an estimated 2-5% of postmenopausal women are affected by endometriosis, often presenting without the typical symptoms of dysmenorrhea or infertility characteristic of endometriosis in reproductive-aged women[4]. In postmenopausal women, endometriosis may present with nonspecific pelvic pain, dyspareunia, and symptoms related to the location of the lesion[1]. While involvement of the genitourinary (GU) tract constitutes about 1% of all endometriosis cases, it is seen in up to 53% of cases of deep endometriosis (DE)[5,6]. A predilection for bladder endometriosis exists in GU endometriosis with a prevalence ratio of bladder-to-ureteral-to-kidney involvement of 40:5:1[5]. Alarmingly, the majority (65%) of urinary tract endometriosis cases present without classic urinary symptoms, with misdiagnosis leading to deleterious terminal kidney loss in severe cases[7]. Symptomatic patients may report flank pain, pelvic pain, and rarely gross hematuria[8,9]. Postmenopausal symptomatic endometriosis is often seen in women with a history of gynecologic surgery for endometriosis, most commonly hysterectomy, and with the use of hormone replacement therapy[5, 9-11]. Herein, we present a case of DE in a postmenopausal woman with unilateral kidney failure to address how endometriosis can present in an uncommon demographic, highlight the surgical importance of the Yabuki space, and address gaps in Sampson's theory of endometriosis pathogenesis.

Case report

A 61-year-old G2P2 postmenopausal woman presented to the emergency department (ED) for acute left lower quadrant and left flank pain rated 10/10 that suddenly woke her up from sleep. The patient reported a longstanding history of dyspareunia and abdominal wall endometriosis. Surgical history was significant for 2 prior cesarean sections and 2 cesarean scar abdominal wall endometrioma excisions in 1996 and 1998 at an outside hospital. She was of normal weight (BMI 24.38) and was using vaginal estrogen cream for genitourinary symptoms of menopause at the time of presentation. Her last menstrual period was in 2010 after an endometrial ablation and a treatment course of Leuprolide injection for abnormal uterine bleeding. Three days prior, she presented to an outside hospital for abdominal pain and computed tomography (CT) scan of the abdomen showed an enlarged left ovary (3.9 x 2.3 cm) and subacute left hydronephrosis from a downstream ureteral obstruction. The patient was discharged with an outpatient Urology appointment. In our ED on presentation, the initial radiology read on CT scan of the abdomen was notable for a mass along the left distal cervix measuring 4.2 x 3 cm concerning for cervical cancer and severe left hydroureter with a transition point just above the left ureterovesical junction, chronic left hydronephrosis, and left renal cortical thinning consistent with a chronic process (**Figure 1**). The gynecology service was consulted to evaluate for possible cervical cancer. A pelvic exam was notable for significant pelvic floor tenderness, with a normal-appearing cervix, normal-sized non-tender uterus, and a Papanicolaou smear was collected. Urology was consulted, and the patient underwent a percutaneous left nephrostomy tube placement. After the nephrostomy tube placement, repeat imaging via pelvic magnetic resonance imaging (MRI) revealed a normal cervix, a linear area of fibrotic scarring extending from left cervix to the ventral aspect of rectal vault, thickening of the left round ligament, and tenting of the left ovary by a spiculated left pelvic lesion involving the left ureter, concerning for deep endometriosis (**Figure 2**). Left kidney function was found to be 28% on renal lasix. This was considered an overestimation of a nonfunctional left kidney supported by cortical atrophy on CT scan and scant output from nephrostomy tube. Patient preference was for nephrectomy at the time of GYN surgery. The patient's vaginal estrogen was discontinued, and she was started on anastrozole with a plan for a total laparoscopic hysterectomy, bilateral salpingo-oophorectomy, endometriosis resection, cystoscopy, and left nephro-ureterectomy with the Minimally Invasive Gynecologic Surgery (MIGS) and Urology service.

The patient was taken to the operating room and intraoperative findings were notable for a normal-sized uterus with multiple small intramural myomas, dense adhesions of the bladder to the lower uterine segment, left ovary and fallopian tube with dense adhesions to the pelvic sidewall, and a 3 cm deep endometriotic nodule in the left parametrium. The nodule extended from the left pelvic sidewall to the retroperitoneal space of Yabuki, bordered by the anterior surface of the uterus posteriorly and the ureter inserting into the bladder[12], encompassing the left distal ureter (**Figures 3, 4, 5**).

Cystoscopy was only notable for an absent left ureteral jet. The patient underwent a total laparoscopic hysterectomy with bilateral uterine artery ligation at the origin, bilateral salpingo-oophorectomy, excision of endometriosis with ligation and excision of the distal ureteral mass (**Figure 6**), and cystoscopy by the MIGS service. Urology performed a laparoscopic left nephro-ureterectomy. There were no intraoperative or postoperative complications. The estimated blood loss was 100 ml. The patient was admitted for 2 days for routine postoperative care. At 4 weeks postoperatively, the patient was doing well and had resolution of her symptoms.

The pathology of the left ureter showed extensive extrinsic polypoid endometriosis composed of an admixture of endometriotic stroma and atrophic glands showing cystic changes with features resembling those of an endometrial polyp (**Figure 7**). In addition, there was adenomyosis of the uterus, seromucinous adenofibromas of the ovaries with foci reminiscent of endometriosis, and para-tubal endometriosis of the right fallopian tube.

Discussion

DE presenting as hydronephrosis in a postmenopausal woman is a rare finding. To date, there have been twelve reported cases of ureteral endometriosis in postmenopausal women[8-10,13-15] . This is likely an underestimation, as the literature commonly omits information on menopausal status and is more likely to report the age of the patient population. Prompt diagnosis of DE and surgical management are necessary to reliably exclude malignancy, prevent loss of kidney function, and to improve the quality of life[4]. It is estimated that 30% of patients with ureteral endometriosis have experienced reduced kidney function at the time of diagnosis[16]. According to the group of Kvaskoff et al. endometriosis carries a risk of malignant transformation with a summary relative risk of ovarian cancer of 1.93[17]. Medical management of refractory symptoms in pre-menopausal patients includes combination oral contraceptives, progestins, levonorgestrel intrauterine system (LNG-IUS), GnRH analog, and

aromatase inhibitors[3]. While there is limited data regarding the management of postmenopausal endometriosis, aromatase inhibitors have been shown to improve symptoms refractory to surgical excision in case reports[18]. Endometriosis is most commonly diagnosed in women of reproductive age partially due to the key role estrogen plays in its pathogenesis. Some studies have identified hormone replacement therapy (HRT) with estrogen-only as a risk factor for progression and malignant transformation of endometriosis[3]. As a result, it is advised to use combination hormone replacement therapy (HRT) when indicated regardless of the presence of a uterus in individuals with endometriosis[3]. However, the heterogeneity of endometriosis in different contexts makes it difficult to prove a single etiopathologic model for this complex disease. In this case, we postulate that the direct vaginal estrogen exposure of our patient may have contributed to the progression of a pre-existing endometriotic lesion involving the ureter, leading to polypoid endometriosis which was not seen in the endometriotic lesions at other sites from the same patient. Polypoid endometriosis refers to extrauterine endometriotic tissue with histologic features reminiscent of an endometrial polyp, which can clinically mimic a malignant tumor. Although endometriosis typically affects younger women with <5% of endometriosis cases seen in postmenopausal women, polypoid endometriosis more frequently occurs in the latter population. In the largest series, 60% of polypoid endometriosis cases were detected in patients over 50 years of age and it has been speculated that hyperestrogenism, particularly due to exogenous hormones, was “almost certainly” a contributing factor in some of the cases.[19] Further studies are needed to assess the effect of exogenous estrogen on endometriosis through both oral and topical HRT. Recommendations suggest the use of progestins in addition to estrogen hormone replacement to treat vasomotor symptoms of menopause in women with endometriosis who require HRT[4,20].

Our case further highlights the clinical importance of the anatomical knowledge of Yabuki space. Endometriosis of the anterior vaginal wall may impact the ureter where it crosses the vagina lateral from posterior to anterior. This finding increases the significance of this potential space in women requiring surgical removal of ureteral endometriosis. Furthermore, we highlight the low diagnostic accuracy of imaging in nonspecialized centers despite the high operator-dependent specificity and sensitivity of ultrasound and MRI in high-volume endometriosis centers around the world[21, 22].

The findings presented in this case highlight the need for robust research into noninvasive

diagnostic tools and alternative theories of endometriosis pathophysiology beyond Sampson's theory that endometriosis is initiated or exacerbated by retrograde menstruation[2]. Postmenopausal women are at risk for endometriosis despite having ceased menstruation. Although this patient had a history of endometriosis in her reproductive years, it appears that she developed new lesions and/or they progressed during menopause. This conclusion is supported by findings of extensive endometriosis and related lesions at multiple sites with an acute onset of symptoms.

Alternative theories that mandate further clinical research include the genetic-epigenetic theory, the mulleriosis theory, and the role of the reproductive and gut microbiome and its metabolome on endometriosis. The genetic-epigenetic theory posits that endometrial lesions are the result of genetic and epigenetic incidents accumulated over time and that typical, cystic, and deep endometriosis lesions are uniquely influenced by a variety of environmental factors[23]. Our patient's extensive history of abdominal surgery indicates increased inflammation and stress that could have advanced an existing predisposition to endometriosis. The mulleriosis theory suggests that deep endometrial lesions are the product of previously undifferentiated cells of the mullerian duct that develop into endometrial-like cells in response to estrogen and other factors[24]. The presence of deep endometriosis with the use of local estrogen in our patient bolsters this theory. The bacterial contamination theory argues that gastrointestinal and genitourinary microbial dysbiosis produces a cycle of worsening inflammation, adhesion, and angiogenesis that induces the growth of endometriotic lesions[25,26]. Lower estrogen levels in menopause result in vaginal microbiome perturbations[27]. Therefore, microbiome dysbiosis may have a role in endometriosis in this population.

Conclusion

We present the diagnosis and treatment of a postmenopausal woman with deep endometriosis of the ureter that resulted in terminal kidney loss. It is important to consider the diagnosis of endometriosis in this population as nonspecific pelvic pain may be the only early presenting feature. We highlight the use of topical estrogen as a potential risk factor in the growth of existing endometriotic lesions and the space of Yabuki as a key surgical landmark in the excision of DE. This case underscores the urgent need for research into menstruation science and endometriosis.

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Figures:

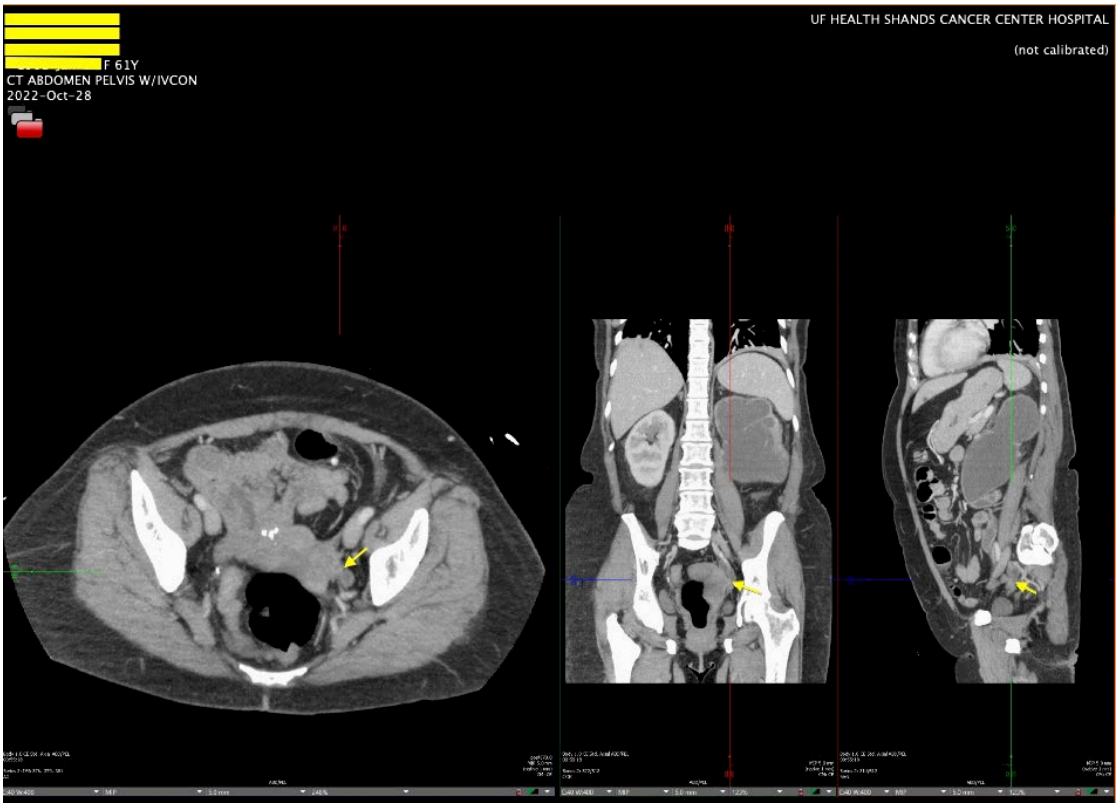

Figure 1: CT Abdomen Pelvis with left hydroureter and chronic atrophy of ipsilateral kidney

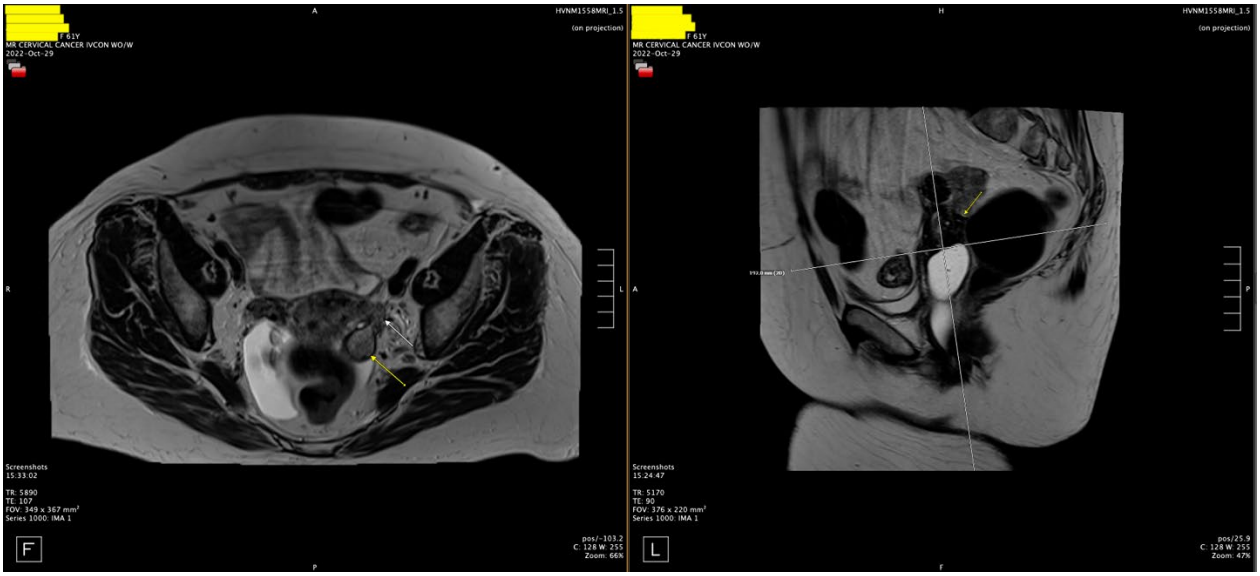

Figure 2: Pelvic MRI with fibrotic scarring from left cervix to the ventral aspect of rectal vault, thickening of the left round ligament, and tenting of the left ovary by a spiculated left pelvic lesion involving the left ureter

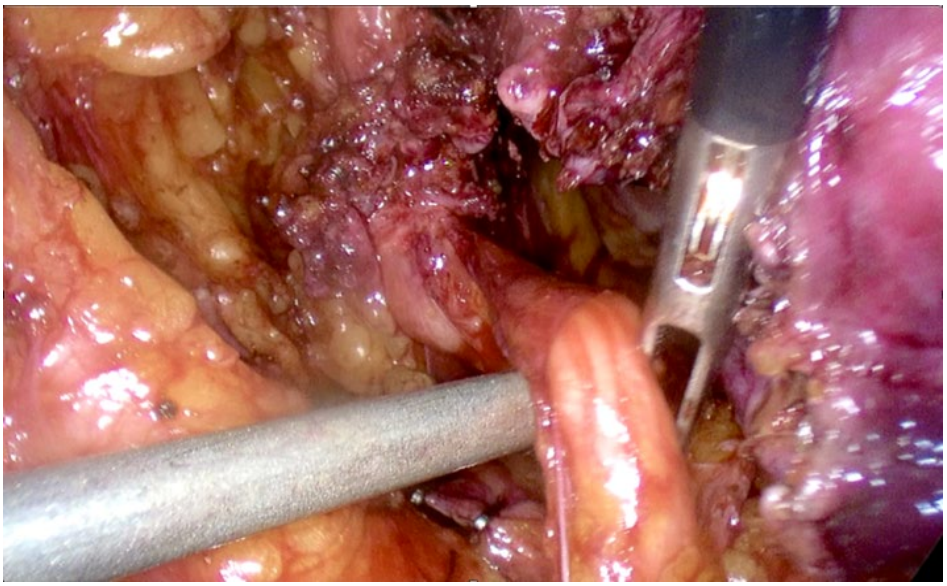

Figure 3: Left hydroureter with occlusive distal deep endometriosis nodule

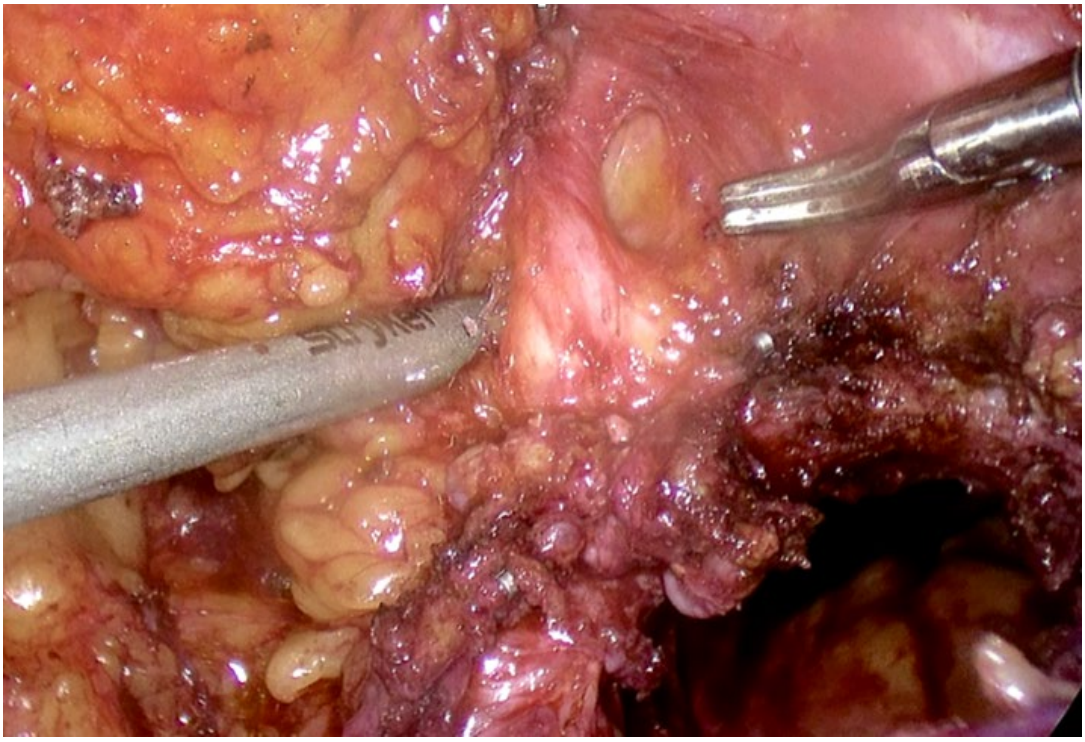

Figure 4: Development of left distal ureter in Yabuki space

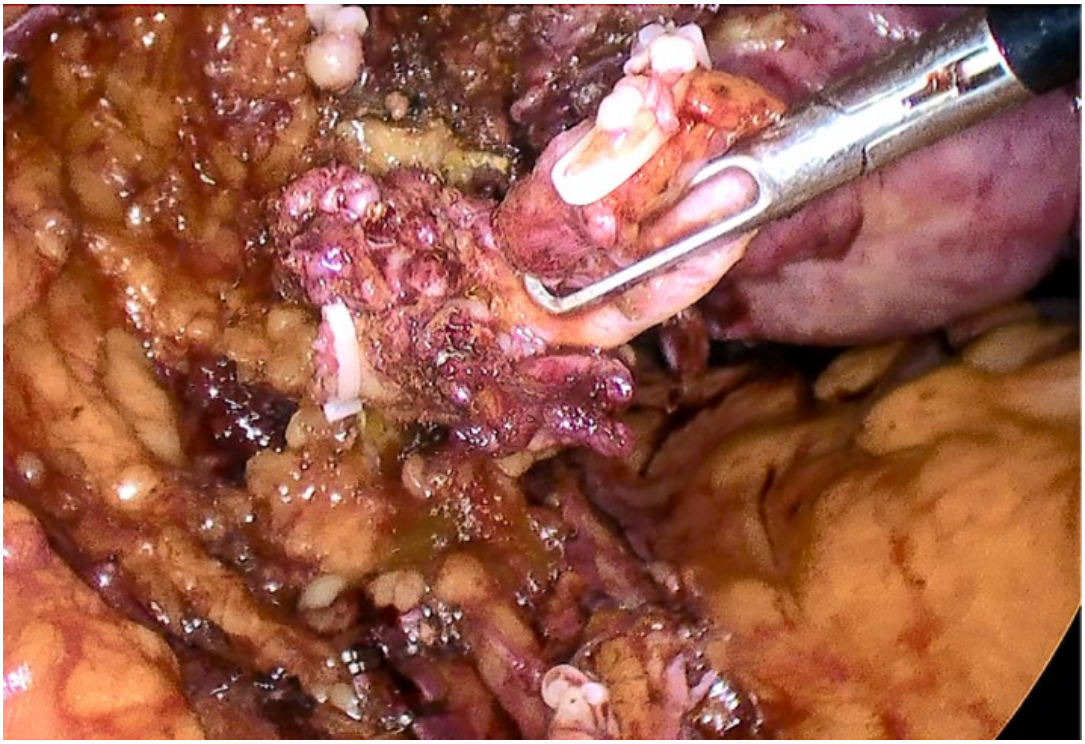

Figure 5: Left hydroureter segment with deep endometriosis

Figure 6: Excised ureteral gross lesion

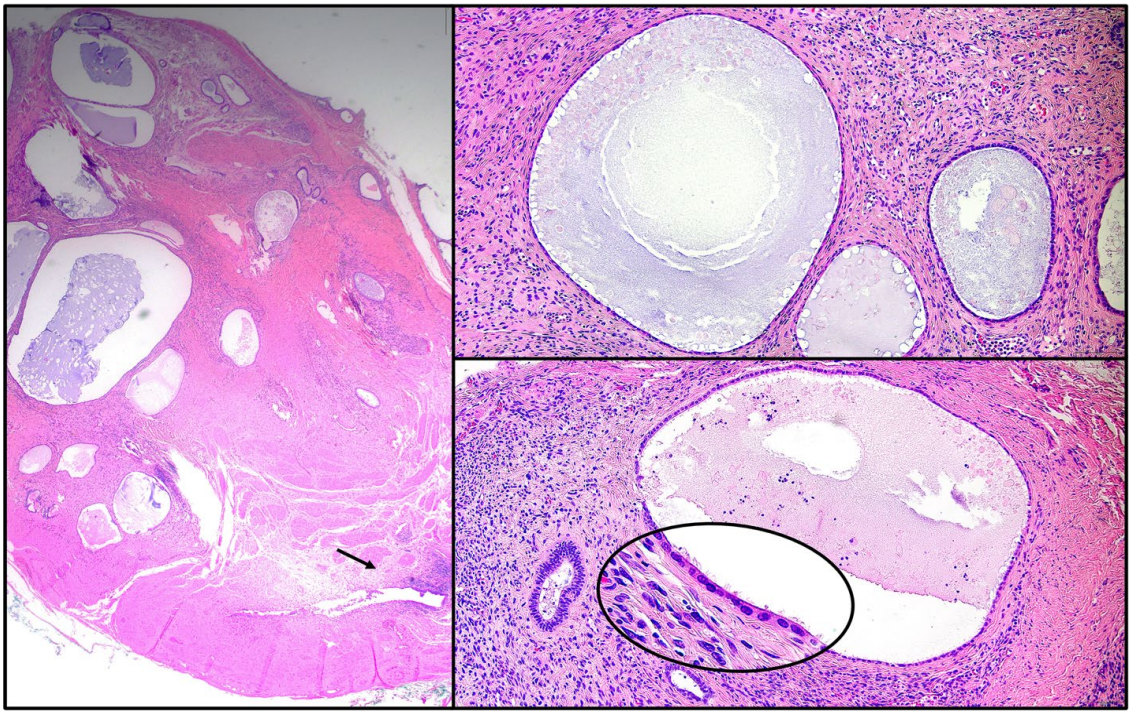

Figure 7: Pathology of the left ureter showing extensive polypoid endometriosis

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Per-Hysteroscopic KCL intra-cardiac embryo-injection and management for Cesarean scare pregnancy Case report (Video article)

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Abstract

The incidence of Cesarean scare pregnancy (CSP) is rising worldwide, due to the increased number of cesarean sections.

This case report is about hysteroscopic management of cesarean scare pregnancy. Where an ectopic embryo intracardiac KCL injection was performed under direct vision by using a 05 mm standard hysteroscope. A second time management, always by hysteroscopy. After a follow up and the vanishment of the trophoblastic signal doppler.

There are many protocols proposed to manage CSP. however, there is no standardized treatment due to the lack of consensus in the medical community.

Managing some CSP by hysteroscopy could be a less mini-invasive option. Especially, when it is possible to trigger a decreased trophoblastic signal Doppler, under a direct visual intracardiac KCL injection. This will prepare for a safe evacuation of the remaining trophoblastic tissue from the inside of the isthmocele.

In conclusion hysteroscopic KCL intra cardiac embryo injection for CSP, under direct visualization realized as shown in this case report could be the base to understand better this ectopic pregnancy, and to get the less invasive option which can be developed.

Key words: ectopic pregnancy; hysteroscope; doppler; injection; Cesarean

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Transperitoneal migration of spermatozoa with Ruptured Ectopic gestation in a Unicornuate uterus (U4b)– A Case report (Video)

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Abstract

Objective: A rare case scenario of Transperitoneal migration of Spermatozoa with Ruptured Ectopic gestation in a Unicornuate uterus (U4b)– A Case report.

Design: Retrospective study - review of surgical procedure

Setting: Patient consent was taken. She was operated at a hospital in Mumbai. Procedure was done under general anaesthesia. Port configuration used was 1 supra umbilical 10 mm port for optics and 2 left sided ipsilateral 5 mm accessory ports for the surgery.

Intervention: Laparoscopic right salpingectomy with drainage of the hemoperitoneum

Conclusion: Demonstrating the laparoscopic findings in this rare case of ruptured tubal ectopic gestation and establishing evidence-based findings of transperitoneal migration of spermatozoa leading to ectopic gestation in the contralateral tube.

Key words: Ectopic pregnancy; Mullerian anomaly; Laparoscopic salpingectomy; transperitoneal migration; hemoperitoneum

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Introduction:

This case report describes a case of Transperitoneal migration of spermatozoa leading to an ectopic gestation.

The patient is a 29-year-old, Gravida 1 Para 0, Married for 2 years, no previous abortions or living issues.

She has not had any prior scans so is unaware of the congenital mullerian anomaly which had not been diagnosed prior to this episode of ruptured tubal ectopic pregnancy.

The patient had a congenital uterine anomaly of class U4b with Left sided Unicornuate uterus and the ectopic gestation was noted in the Right tube (on the side of the undeveloped uterine horn) which subsequently ruptured causing hemoperitoneum (as is seen in figure 1 and 2)

The patient underwent an emergency laparoscopic salpingectomy. (as is seen in Figure 3)

The patient was a 32-year-old with complaints of severe abdominal pain for 1 day and bleeding vaginally.

She had history of 6 weeks amenorrhea and a positive Urine pregnancy test. A 3D ultrasound confirmed the findings of a ruptured right tubal ectopic gestation with hemoperitoneum and a Mullerian anomaly of class U4b (Unicornuate uterus on the left side).

She was taken up for emergency Laparoscopic salpingectomy under general anesthesia and the Intra operative findings confirmed the diagnosis (Operative pictures attached)- as is seen in figure 4.

This suggests a pathogenesis of transperitoneal migration of sperm as has been recorded previously in literature as cited below. The right sided salpingectomy was performed and final histopathology of the specimen confirmed the diagnosis of an ectopic pregnancy.

The pathophysiology as suggested by the authors is that the sperms transmigrated through the uterus into the left patent fallopian tube and through the peritoneum to fertilize the ovum in the right sided fallopian tube to then lead to an ectopic pregnancy in the right tube as there is no direct pathway to the uterus from the right fallopian tube. The ovulation however could have occurred from either side as the ovum could be released into the pouch of Douglas in the peritoneal free fluid and then picked up by the sweeping motion of the fimbria of the right fallopian tube to then implant in the tubal epithelium. This appears to be the only logical explanation for occurrence of this rare phenomena as seen in this case report.

Review of literature

This case represents the phenomenon of contralateral sperm transperitoneal migration: sperm gaining access to the left oviduct after entering the peritoneal cavity via the right oviduct. The ovum from the left ovary after being successfully fertilized could not be transported into the uterine cavity due to the previous segmental resection, ultimately resulting in an ectopic pregnancy. [1]

Intraperitoneal sperm transmigration occurs approximately half the time in effecting spontaneous human pregnancies. To minimize the risk of ectopic tubal pregnancy in woman with unilaterally damaged fallopian tubes, salpingectomy should be the preferred surgical treatment, rather than attempting tubal salvage and repair.[2]

This is the first report of an intrauterine pregnancy following timed coitus, resulting from transperitoneal sperm and/or oocyte migration as the oocyte originated from an ectopic (undescended) ovary. [3]

The occurrence of ectopic pregnancy distal to complete tubal occlusion or separation (in a tubal segment without luminal continuity to the uterus) was explored among reported tubal pregnancies, particularly those following sterilization. Presumably such pregnancies result from transperitoneal migration of sperm.

Pregnancy occurring in a tubal segment without luminal continuity to the uterus without prior sterilization was only rarely reported.[4]

Congenital mullerian anomalies and their classification -

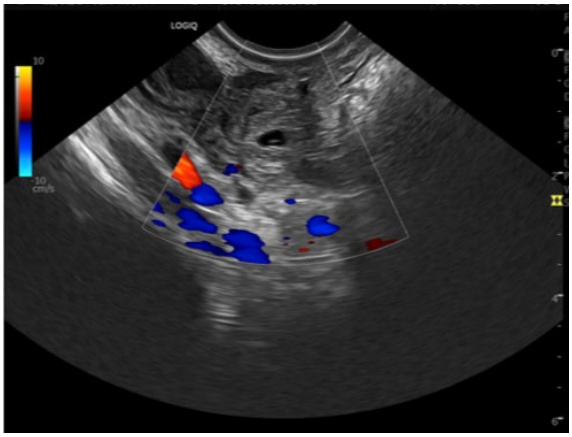

Figure 1: Ultrasound image of the tubal ectopic gestation in the right tube

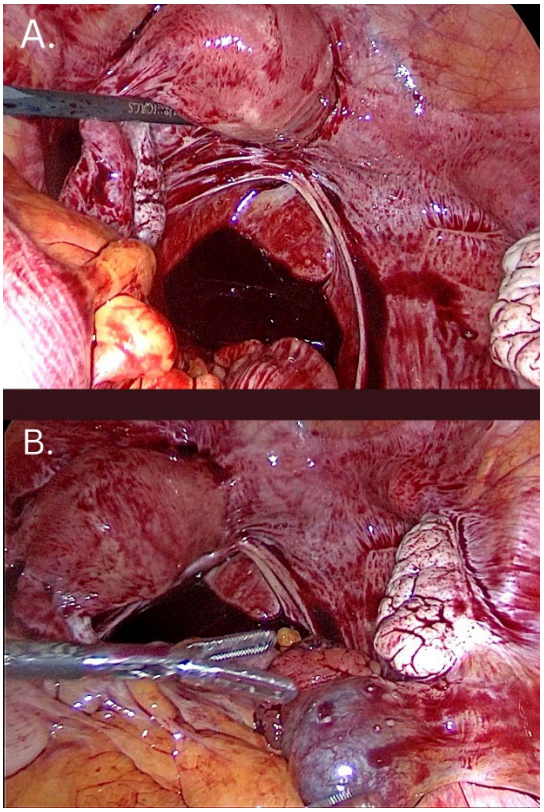

Figure 2

A) Shows the initial operative picture clearly demonstrating the Ruptured tubal ectopic gestation with Hemoperitoneum in the Pouch of Douglas. The Mullerian anomaly can be clearly identified and is seen as a normal well developed uterine horn on the left side with a normal left adnexal complex. The Right side however demonstrates absent uterus with rudimentary undeveloped horn and no cavity.

B) The right ovary is normal and the right sided tube shows the ectopic gestation of size about 3x4 cm with active haemorrhage through the fimbrial end. The Cornual side of the tube does not show any communication with the uterus suggesting an Etiopathogenesis of transperitoneal migration of the Sperm to then undergo implantation of the embryo in the right tube

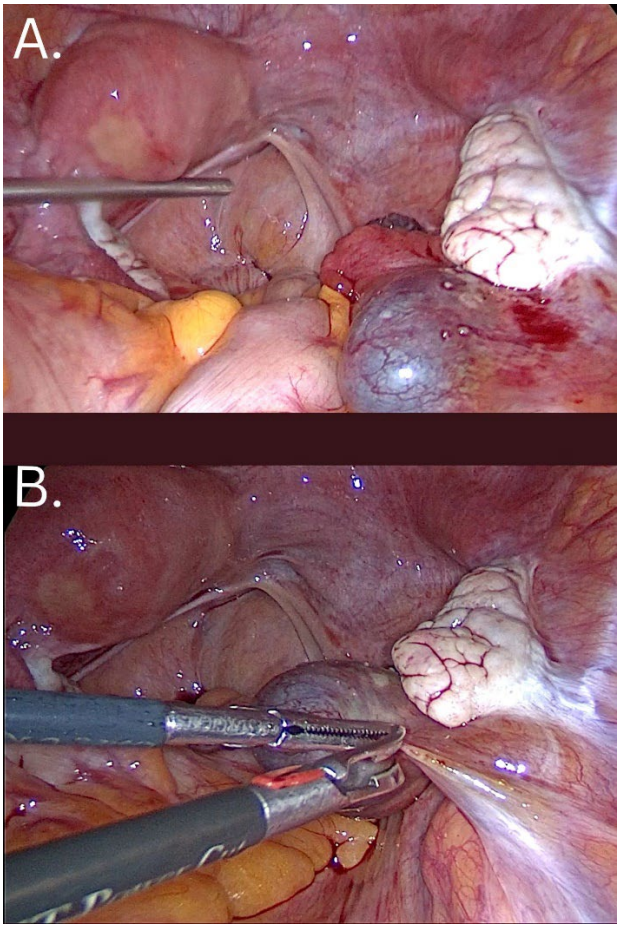

Figure 3

A Shows the laparoscopic view after giving a saline wash.

B Findings were confirmed and Right salpingectomy was done using standard

instruments

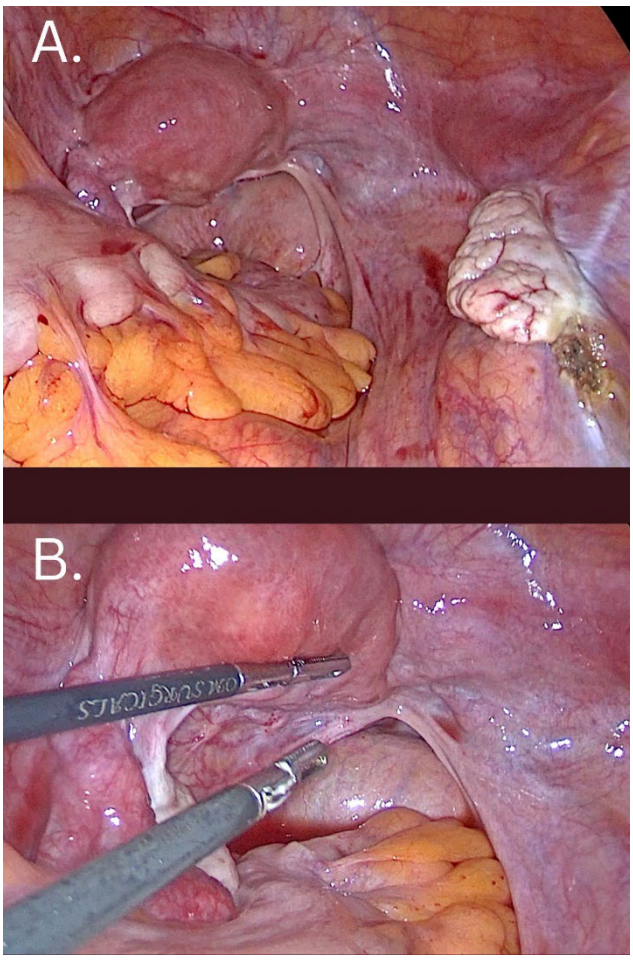

Figure 4

A- Shows the final operative picture after salpingectomy and thorough saline lavage.
B- The Unicornuate uterus is clearly visible with the rudimentary undeveloped horn on the right side. The specimen of the right tube was sent for histopathology and confirmed the diagnosis of ectopic pregnancy in the right tube.

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