

Comparison Between Sonography-Based and Surgical Evaluation of Endometriotic Lesions Using the #Enzian Classification – A Retrospective Data Analysis

Vergleich zwischen Ultraschall-basierter und chirurgischer Evaluierung von Endometrioseherden mittels #Enzian-Klassifikation – eine retrospektive Datenanalyse

Authors

Alessandra Di Giovanni^{1*}, Eliana Montanari^{2,3*} , Gernot Hudelist^{2,4}, Mario Malzoni¹, Joerg Keckstein^{4,5}

Affiliations

- 1 Centre for Advanced Pelvic Surgery, Endoscopica Malzoni, Avellino, Italy
- 2 Department of Gynecology, Center for Endometriosis, Hospital St. John of God, Vienna, Austria
- 3 Department of Obstetrics and Gynecology, Medical University of Vienna, Vienna, Austria
- 4 Stiftung Endometrioseforschung (SEF), Westerstede, Germany
- 5 Gynecological Clinic Drs Keckstein, Villach, Austria

Key words

lesion size, preoperative evaluation, #Enzian classification, transvaginal sonography (TVS), THEMES, surgery

received 03.07.2021

accepted 26.11.2021

published online 28.03.2022

Bibliography

Ultraschall in Med 2023; 44: 290–298

DOI 10.1055/a-1713-3573

ISSN 0172-4614

© 2022, Thieme. All rights reserved.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

Correspondence

Dr. Eliana Montanari, PhD

Hospital St. John of God

Department of Gynecology, Center for Endometriosis, Vienna, Austria

eliana.montanari@meduniwien.ac.at

ABSTRACT

Purpose To compare the location and sizes of deep endometriosis (DE) lesions evaluated by preoperative transvaginal sonography (TVS) in different #Enzian compartments with intraoperatively assessed DE location and size.

Materials and Methods Retrospective data analysis of 93 women undergoing TVS and surgery for DE in 2019 at a tertiary referral center for endometriosis.

Results #Enzian compartment C (rectum) showed the highest rate of exact concordance with 74 % of cases, which increased to 87 % when a tolerance margin of a maximum of 3 mm for TVS measurements was taken into account. For compartment B (uterosacral ligaments, parametria) and compartment A (vagina, rectovaginal space), the rates of exact concordance were slightly lower. In compartment O (ovary), high exact concordance rates similar to those observed for compartment C were observed. In compartment T (tubo-ovarian unit), most reliable estimations were seen for slight (TVS T1) and severe adhesions (TVS T3). There were only a few cases of missed lesions as well as false positives on TVS: Sensitivity was 100 % for all compartments except for A and B left (97 %) and FB (urinary bladder, 86 %); specificity was 100 % for FB, FI (other intestinal locations), FU (ureters) and O right, 86 %-98 % for A, B right, C, O left and FO (other extragenital lesions) and 70 % for B left.

Conclusion The preoperative evaluation of the location and size of DE lesions by TVS in different #Enzian compartments is accurate, providing a detailed presurgical description of the extent of ovarian and deep endometriosis and associated minor or severe adhesions.

ZUSAMMENFASSUNG

Ziel Vergleich der Evaluierung mittels transvaginalem Ultraschall (TVUS) von Lokalisation und Größe tief infiltrierender Endometriose (TIE)-Läsionen mit der intraoperativen Evaluierung in verschiedenen #Enzian Kompartimenten.

Material und Methoden Retrospektive Datenanalyse von 93 Frauen, die sich im Jahr 2019 in einem tertiären Endometriosezentrum nach TVUS einer chirurgischen TIE-Sanierung unterzogen.

Ergebnisse #Enzian Kompartiment C (Rektum) zeigte die höchste Rate exakter Übereinstimmungen mit 74 % der Fälle. Bei Berücksichtigung eines Toleranzbereichs für die TVUS-Messungen von max. 3 mm stieg diese auf 87 %. Für Kompartiment B (Uterosakral-ligamente, Parametrien) und Komparti-

* These authors contributed equally.

ment A (Vagina, Septum rectovaginale) waren die Raten an exakten Übereinstimmungen etwas geringer. In Kompartiment O (Ovar) wurden hohe exakte Übereinstimmungsraten ähnlich wie Kompartiment C beobachtet. In Kompartiment T (tubo-ovarielle Einheit) zeigten sich die verlässlichsten Schätzungen für leichte (TVUS T1) und schwere Adhäsionen (TVUS T3). Es gab nur wenige Fälle übersehener Läsionen sowie falsch positiver Befunde: Die Sensitivität war für alle Kompartimente 100 %, außer für A, B links (je 97 %) und FB (Harn-

blase, 86 %); die Spezifität war 100 % für FB, FI (andere intestinale Lokalisationen), FU (Ureteren) und O rechts, 86 %-98 % für A, B rechts, C, O links und FO (andere extragenitale Läsionen) und 70 % für B links.

Schlussfolgerung Die präoperative Evaluierung von Lokalisation und Größe von TIE Läsionen mittels TVUS in verschiedenen #Enzian Kompartimenten ist akkurat und bietet eine detaillierte Beschreibung des Ausmaßes ovarieller und TIE sowie assoziierter leichter oder schwerer Adhäsionen.

Introduction

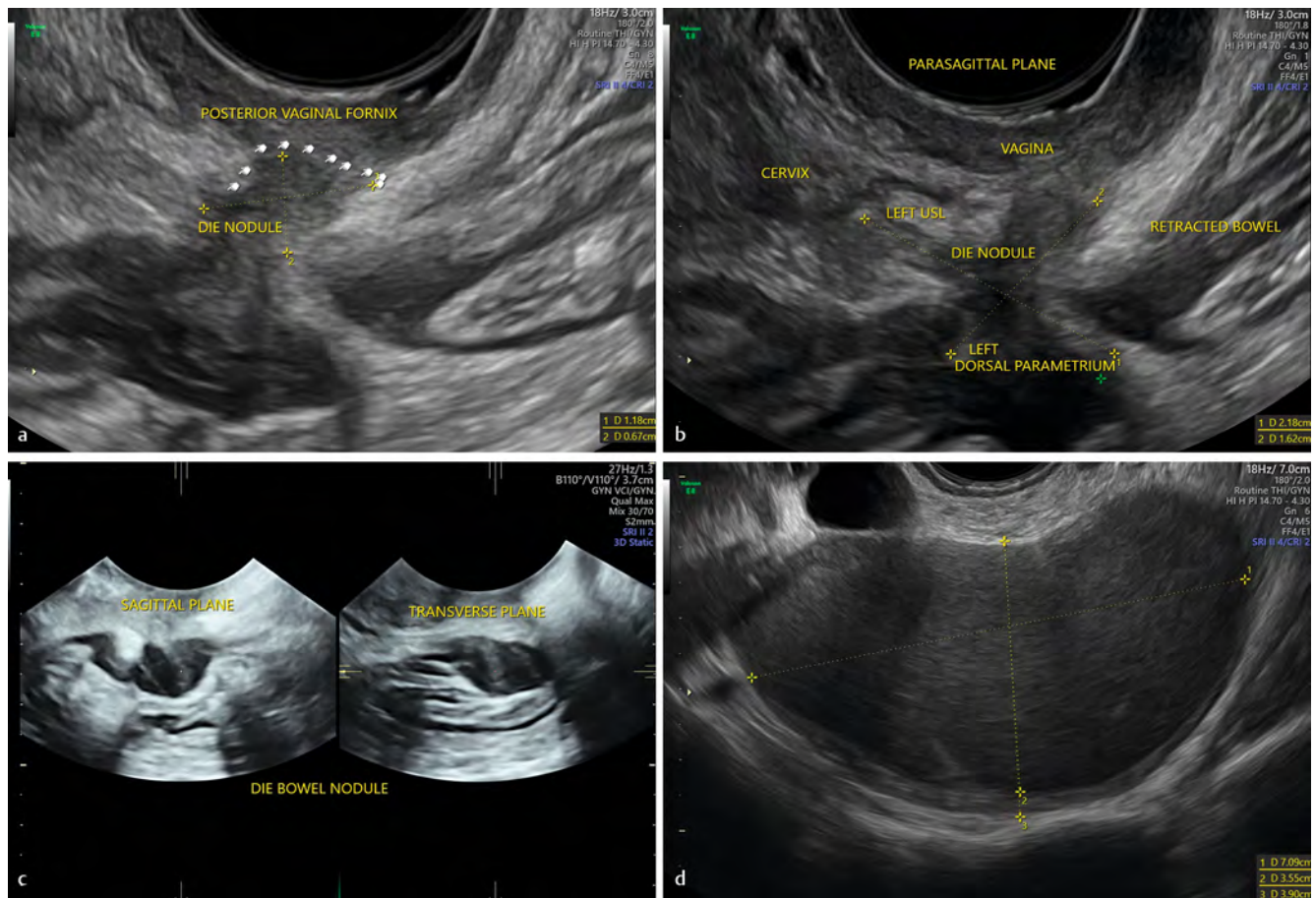
Endometriosis may manifest in different forms, with superficial peritoneal lesions representing the mildest form of the disease. Endometriotic cysts of the ovaries are frequent findings and varying degrees of associated adhesions may also be encountered. Deep endometriosis (DE) may affect the urinary bladder, rectum, vagina, rectovaginal septum, uterosacral ligaments (USLs), or parametria [1, 2, 3, 4]. Various classification systems have been developed to describe the extent of the disease. Many of them are based on an intraoperative evaluation of peritoneal disease location and severity. In contrast, the Enzian classification, which was originally created in 2003 in an attempt to better describe the location and severity of DE [5], until now focused on deep disease. However, efforts have been made to create an updated, universally usable and applicable classification – the #Enzian classification, which was published in January, 2021 and now also comprises the assessment of endometriotic lesions of the ovaries and the peritoneum as well as adhesions of the ovaries and tubes in addition to DE [6]. As a consequence, it may enable a more comprehensive representation of the extent of the disease. The #Enzian classification was primarily developed as a surgical score, but the focus was also put on the possibility to additionally apply it to the findings of different imaging techniques such as transvaginal sonography (TVS) and magnetic resonance imaging (MRI). This is particularly important in light of the fact that surgical planning may be facilitated and conservative treatment monitoring may also be made easier with a uniform language. The #Enzian classification aims to evaluate all #Enzian compartments also by TVS or MRI except for compartment P, which describes peritoneal lesions that can hardly be detected by imaging [6]. The aim of the present study was to exactly compare endometriotic lesion sizes evaluated by preoperative TVS and surgery for all #Enzian compartments in which a differentiation of specific severity grades is foreseen by this classification. Furthermore, the severity grades of adhesions of the ovaries and tubes were compared between TVS and surgery, and the sensitivities and specificities for the detection of endometriotic lesions and adhesions by TVS in the different #Enzian compartments were calculated.

Methods

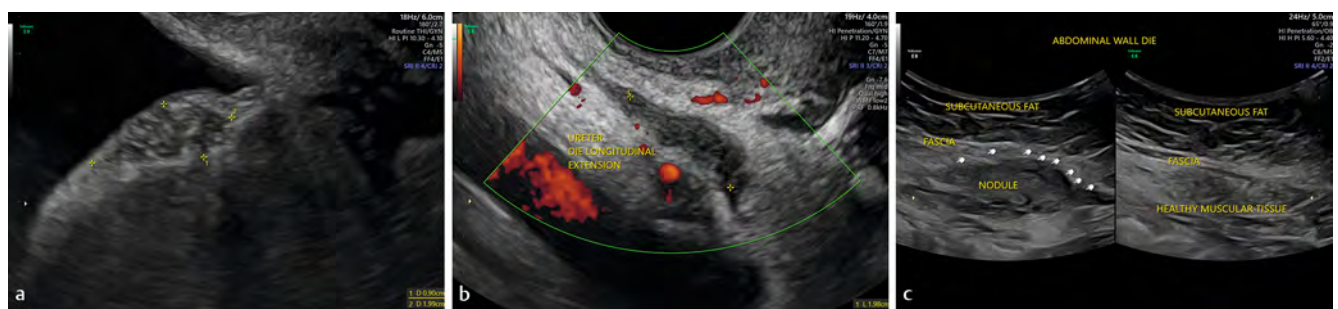
This study is a retrospective data analysis of all women aged 18 years or older who underwent preoperative TVS evaluation fol-

lowed by surgical treatment for DE at a tertiary referral center for endometriosis in Italy between January 1, 2019 and December 31, 2019. The study was approved by the local IRB and the STARD guidelines were followed for this study. Only patients with TVS performed within three months before the surgical intervention were included. Patients with diagnosed or suspected malignancy, a previous colorectal surgery, or a previous surgery for DE including vaginal resection, full thickness bowel resection, or excision of a DE lesion involving the urinary bladder were excluded. TVS findings regarding endometriotic lesions were extracted from medical records. In this regard, the location and lesion size of every endometriotic lesion were described following the criteria of the #Enzian classification [6]. Furthermore, the exact description of lesion size in mm was extracted. All preoperative sonographic examinations had been carried out by a gynecologist with extensive ultrasound experience especially in the field of endometriosis (A.D.G.) using a Voluson E8 ultrasound device (GE Healthcare Austria GmbH, Vienna, Austria). Routinely, transabdominal sonography had been performed in addition to TVS, for example to evaluate the kidneys with regard to hydronephrosis in the presence of DE or to assess the presence of endometriotic lesions in women with upper abdominal pain. As for the sonographic examinations, the intraoperative findings regarding endometriotic lesions were extracted from the surgery reports and the location and size of each lesion were described following the criteria of the #Enzian classification [6]. Furthermore, the description of lesion size in mm was extracted. In this regard, all lesions had been described in 5 mm increments at surgery (i. e., lesion size of 5 mm, 10 mm, 15 mm, etc.). All surgeries had been performed by a pelvic surgeon and his team of gynecologic surgeons with extensive experience in the field of minimally invasive surgery, especially for DE, including urologic and colorectal procedures. The surgeons were not blinded regarding the preoperative TVS examination, as the TVS examinations are routinely performed for the planning of the surgery.

For endometriotic lesions involving #Enzian compartment A (vagina, retrocervical area and/or rectovaginal septum; ► Fig. 1, panel a), B (uterosacral ligaments, parametrium; ► Fig. 1, panel b), and C (rectum; ► Fig. 1, panel c), the definition proposed by the International Deep Endometriosis Analysis group (IDEA) [7] statement was used regarding the vagina and rectovaginal septum. According to the #Enzian classification, the size of an endometriotic lesion in #Enzian compartments A, B, and C was de-



► **Fig. 1** Representative ultrasound images of endometriotic lesions in #Enzian compartment A (panel a), #Enzian compartment B (panel b), #Enzian compartment C (panel c), and #Enzian compartment O (panel d).



► **Fig. 2** Representative ultrasound images of endometriotic lesions in #Enzian compartment FB (panel a), #Enzian compartment FU (panel b), and #Enzian compartment FO (in this case a lesion of the abdominal wall, panel c).

scribed as severity stage 1 = lesion size < 1 cm; stage 2 = lesion size 1–3 cm, and stage 3 = lesion size > 3 cm [6].

For #Enzian compartment O (ovary; ► **Fig. 1**, panel d), each side (left/right) was considered separately and the different severity stages of ovarian endometriotic cysts on the respective side were classified as stage 1 = maximal diameter of the lesion (or sum of the maximal diameters of all cysts in the presence of more than one cyst in an ovary) < 3 cm; stage 2 = 3–7 cm and stage 3 = > 7 cm. Furthermore, missing ovaries on one or both sides were recorded.

#Enzian compartment T (tubo-ovarian condition) was again evaluated for each side separately (left/right) and the severity stages were extracted from the TVS and surgery reports using the following criteria: stage 1 = mild adhesions (tube, ovary, and pelvic side wall appearing to adhere to each other); stage 2 = moderate adhesions (additional adhesions to the uterus); stage 3 = severe (adhesions additionally affecting the bowel and/or USL).

Furthermore, DE lesions affecting #Enzian compartment FB (urinary bladder; ► **Fig. 2**, panel a), FI (other intestinal locations, i. e., sigmoid colon, small bowel, etc.), FU (ureters; ► **Fig. 2**, panel

b) and FO (other extragenital lesions; ► Fig. 2, panel c) were evaluated.

#Enzian compartment P (peritoneal lesions) was not evaluated in this study, as it can only be assessed during surgery but not during TVS. Furthermore, due to the retrospective approach of the present study, this information was not available from surgical reports according to the #Enzian criteria. #Enzian compartment FA (adenomyosis) was also not assessed because definitive histological diagnosis regarding adenomyosis was not available for all cases.

Endometriosis was confirmed histologically in all included cases. Different patient characteristics such as age, body mass index, gravidity, parity, as well as data on preoperative pain symptoms such as dysmenorrhea, dyspareunia, dysuria, dyschezia, infertility, constipation, diarrhea, and rectal bleeding were extracted from the patients' charts.

Statistical Analysis

Data were represented by descriptive statistics. For #Enzian compartments A, B, C, and O, the measurements in mm were recorded in addition to the severity grades of the #Enzian classification. For TVS, they were given as the sizes measured in 1 mm increments during the examination, whereas in the case of surgery, a

► Table 1 Patient characteristics (n = 93).

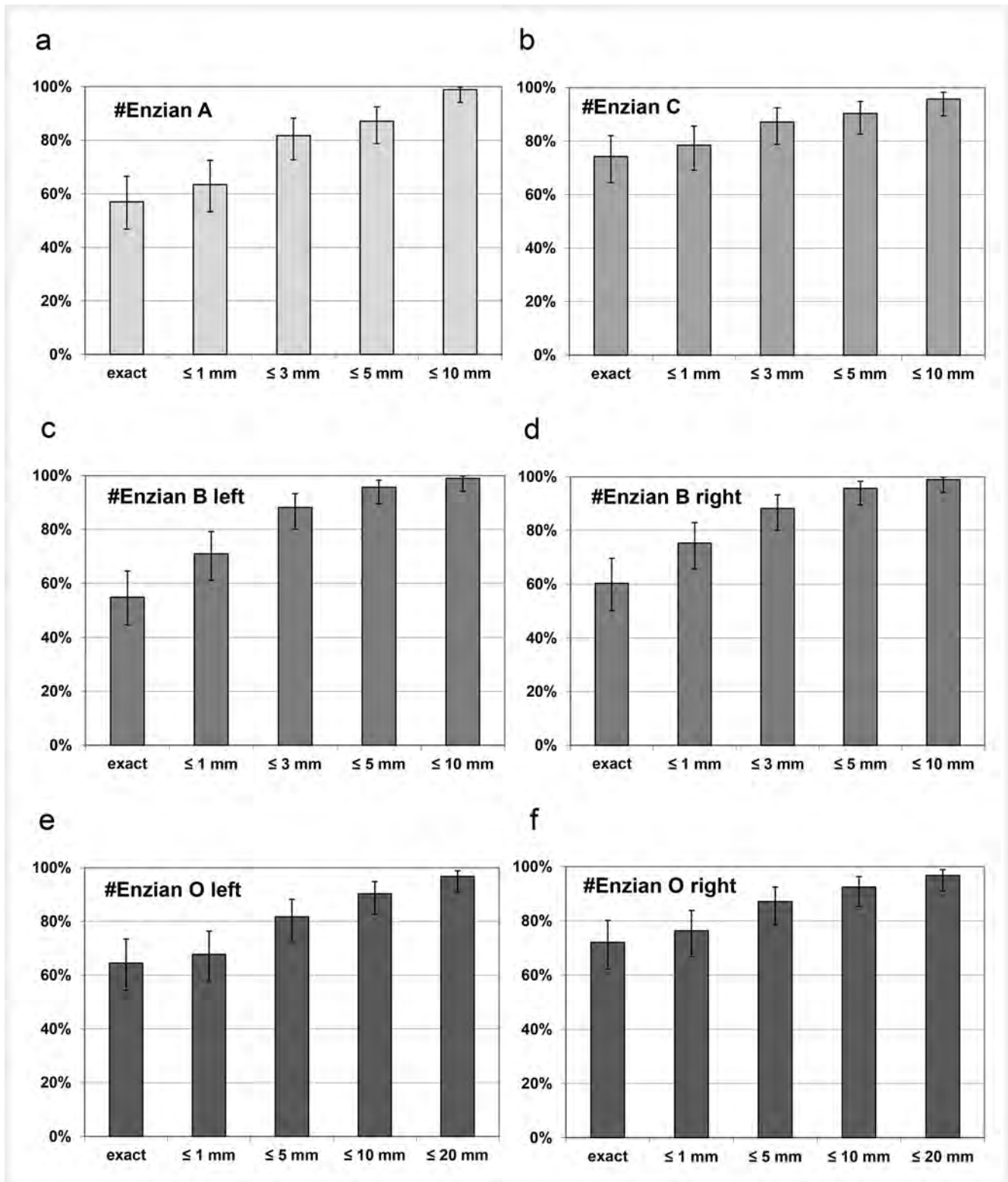
Patient characteristics	Value
Age [years], mean ± SD ^a	37.3 ± 6.6
BMI ^b [kg/m ²], mean ± SD ^a	23.7 ± 3.9
Gravidity	
0, %	62
1, %	23
2, %	11
3, %	3
Parity	
Nulliparity, %	69
Primiparity, %	18
Parity of 2, %	12
Parity of 3, %	1
Preoperative symptom	
Dysmenorrhea, %	95
Dyspareunia, %	96
Dyschezia, %	88
Dysuria, %	32
Infertility, %	43
Constipation, %	75
Diarrhea, %	33
Rectal bleeding, %	5

^aSD – standard deviation; ^bBMI – body mass index

► Table 2 Affected #Enzian compartments as assessed by surgery.

Affected #Enzian compartment	Number of cases
#Enzian A (vagina, retrocervical area, RVS ^a)	72
A1	3
A2	67
A3	2
#Enzian B left (left USLs ^b , left parametria)	70
B1	8
B2	58
B3	4
#Enzian B right (right USLs ^b , right parametria)	71
B1	12
B2	56
B3	3
#Enzian C (rectum)	44
C1	0
C2	17
C3	27
#Enzian O left (left ovary)	39
O1	14
O2	21
O3	4
Missing	0
#Enzian O right (right ovary)	31
O1	10
O2	15
O3	6
Missing	6
#Enzian T left (left tubo-ovarian condition)	88
T1	11
T2	25
T3	52
Missing	3
#Enzian T right (right tubo-ovarian condition)	82
T1	16
T2	23
T3	43
Missing	5
#Enzian FB (urinary bladder)	7
#Enzian FU (ureters)	13
#Enzian FI (other intestinal locations)	17

^aRVS – rectovaginal septum; ^bUSLs – uterosacral ligaments



► **Fig. 3** Percentages with respective 95 % confidence intervals of concordance between transvaginal sonography (TVS) measurements and surgery regarding endometriotic lesions in different #Enzian compartments. Exact concordance is given (i. e., the size interval according to TVS being entirely contained in the size interval according to surgery, as outlined in the Methods section), as well as concordance with a tolerance margin for TVS measurements of a maximum of 1 mm, 3 mm, 5 mm and 10 mm (as well as 20 mm for the ovaries, panels **e** and **f**), respectively. Panel **a**: #Enzian compartment A (vagina, retrocervical area, rectovaginal septum). Panel **b**: #Enzian compartment C (rectum). Panel **c**: #Enzian compartment B left (left uterosacral ligament, left parametria). Panel **d**: #Enzian compartment B right (right uterosacral ligament, right parametria). Panel **e**: #Enzian compartment O left (left ovary). Panel **f**: #Enzian compartment O right (right ovary).

description of the lesion sizes in 5 mm increments was recorded. Therefore, if a lesion was recorded on TVS, for example as 10 mm, the real size ranged from 9.5 to 10.5 mm. If a lesion was recorded during surgery as 10 mm, the real size ranged between 7.5 and 12.5 mm. Starting from these considerations, the percentages of concordance (with 95 % confidence intervals) between TVS and surgery were calculated by assessing the number of cases in which the size interval according to TVS was entirely contained in the size interval according to surgery. In this regard, for #Enzian compartments B and O, the left and the right side were evaluated and described separately. For #Enzian compartment T, the findings during TVS and surgery were compared using the #Enzian severity grades. In addition to the exact concordances of the lesion sizes in mm between TVS and surgery, the rates of concordance between the lesion sizes described according to the severity grades of the #Enzian classification were also calculated for compartments A, B, C, and O.

Furthermore, the overall sensitivities and specificities for the detection of endometriotic lesions (or adhesions, respectively) in #Enzian compartments A, B, C, O, FB, FU, FI, and FO by TVS were calculated. Again, for #Enzian compartments B and O, the left and the right sides were considered separately, and the sensitivities and specificities were calculated for each side.

Results

Between January 1, 2019 and December 31, 2019, 93 women who had undergone preoperative TVS and surgical resection of DE were included. The patient characteristics of these women are shown in ► **Table 1**. ► **Table 2** summarizes the number of women affected by endometriotic lesions/adhesions in each #Enzian compartment including the number of cases for each severity grade in the respective compartments.

► **Fig. 3** shows the percentages of cases (with 95 % confidence intervals (CIs)) in which the lesion size measurement by TVS matches exactly with the lesion size seen during surgery. The highest rate of exact concordance was found for #Enzian compartment C,

with exact matches in 74 % of cases (► **Fig. 3**, panel b). When considering a tolerance margin of a maximum of 3 mm for the TVS measurements, 87 % concordant cases were seen. Conversely, the lowest rate of exact concordance was found for #Enzian compartment B left with 55 % (► **Fig. 3**, panel c). However, when considering a maximum tolerance margin of 3 mm, a rate of 88 % concordant cases was seen also in this case. In #Enzian compartments A, C, B left and B right, almost 100 % concordance between TVS and surgery was reached when a maximum tolerance margin of 10 mm (1 cm) was considered. For #Enzian compartment O (ovaries), exact concordance rates of 65 % on the left side and 72 % on the right were found (► **Fig. 3**, panels e and f). With a maximum tolerance margin of 10 mm, concordance rates of 90 % on the left side and 92 % on the right side were reached and with a maximum tolerance margin of 20 mm, 97 % on each side was achieved.

For #Enzian compartment T (tubo-ovarian condition), reflecting adhesions of the ovary and tube to the pelvic side wall and – depending on the severity grade – also to the uterus or the bowel and/or USL, the comparisons between the findings during TVS and surgery according to the #Enzian severity grades are shown in ► **Table 3**. The highest concordances in this compartment were seen for severe adhesions: severe adhesions seen on TVS (i. e., TVS T3) were confirmed during surgery in 86 % cases for the left side and in 84 % on the right side. In the remaining cases of TVS T3, the adhesions were assessed as moderate (i. e., T2) during surgery. None of the TVS T3 assessments turned out to be only slight adhesions (T1) or even cases without any adhesions (T0). Moderate adhesions on TVS (TVS T2) were classified as T2 in 68 % (left side) and 59 % (right side) of cases during surgery, whereas the remaining cases were classified as either slight or severe on both sides. Slight adhesions on TVS (T1) were confirmed as such during surgery in 75 % (left side) and 77 % (right side) of cases, whereas for the remaining TVS T1 cases, no adhesions were found during surgery (T0). None of the TVS T1 cases turned out to be moderate (T2) or severe (T3) adhesions during surgery.

► **Table 3** #Enzian severity grades of adhesions in #Enzian compartment T (tubo-ovarian condition) according to preoperative transvaginal sonography and surgery.

		Surgery			
		T0	T1	T2	T3
Transvaginal sonography (TVS)	Left side				
	T0, % of TVS T0	<u>0</u>	0	0	0
	T1, % of TVS T1	25	<u>75</u>	0	0
	T2, % of TVS T2	0	20	<u>68</u>	12
	T3, % of TVS T3	0	0	14	<u>86</u>
	Right side				
	T0, % of TVS T0	<u>100</u>	0	0	0
	T1, % of TVS T1	23	<u>77</u>	0	0
	T2, % of TVS T2	0	22	<u>59</u>	19
	T3, % of TVS T3	0	0	16	<u>84</u>

► **Table 4** #Enzian severity grades of lesions in #Enzian compartments A, B (left/right), C and O (left/right) according to preoperative transvaginal sonography and surgery.

	Surgery			
	A0	A1	A2	A3
A0, % of TVS A0	<u>90</u>	5	5	0
A1, % of TVS A1	14	<u>29</u>	57	0
A2, % of TVS A2	3	0	<u>97</u>	0
A3, % of TVS A3	0	0	50	<u>50</u>
Left side				
B0, % of TVS B0	<u>89</u>	0	11	0
B1, % of TVS B1	37	<u>37</u>	26	0
B2, % of TVS B2	0	2	<u>96</u>	2
B3, % of TVS B3	0	0	0	<u>100</u>
Right side				
B0, % of TVS B0	<u>100</u>	0	0	0
B1, % of TVS B1	13	<u>46</u>	42	0
B2, % of TVS B2	0	2	<u>98</u>	0
B3, % of TVS B3	0	0	25	<u>75</u>
C0				
C0, % of TVS C0	<u>100</u>	0	0	0
C1, % of TVS C1	0	<u>0</u>	0	0
C2, % of TVS C2	11	0	<u>89</u>	0
C3, % of TVS C3	0	0	4	<u>96</u>
Left side				
O0, % of TVS O0	<u>100</u>	0	0	0
O1, % of TVS O1	13	<u>80</u>	7	0
O2, % of TVS O2	0	10	<u>90</u>	0
O3, % of TVS O3	0	0	20	<u>80</u>
Right side				
O0, % of TVS O0	<u>100</u>	0	0	0
O1, % of TVS O1	0	<u>73</u>	27	0
O2, % of TVS O2	0	17	<u>83</u>	0
O3, % of TVS O3	0	0	25	<u>75</u>

► **Table 4** shows the concordance rates between the lesion sizes during TVS and surgery evaluated according to the #Enzian severity grades for compartment A, B (left/right), C, and O (left/right). The concordance rates for the assignment to the specific severity grade ranged between 73 % and 100 %, except for A1 and B1 lesions, where only 29 % to 46 % of the A1 and B1 lesions on TVS were confirmed as such during surgery. The other TVS A1

and B1 lesions were classified as lesions in adjacent severity grades (► **Table 4**).

Confirmation rates by surgery (not sensitivities and specificities, but percentages of positives on sonography of all true positives as well as percentages of negatives on sonography of all true negatives) of the presence or absence of an endometriotic lesion during sonographic examination in different #Enzian compartments were as follows:

- FB (urinary bladder): 100 % (95 % CI 61 % – 100 %); 99 % (95 % CI 94 % – 100 %).
- FI (other intestinal locations): 100 % (95 % CI 81 % – 100 %); 100 % (95 % CI 95 % – 100 %).
- FU (ureters): 100 % (95 % CI 77 % – 100 %); 100 % (95 % CI 95 % – 100 %).
- FO (other extragenital locations): 71.4 % (95 % CI 36 % – 92 %); 100 % (95 % CI 96 % – 100 %).

In summary, one DE lesion of the urinary bladder was not detected by TVS and the only two discordant findings in #Enzian compartment FO were a lesion at the level of the umbilicus and another one in the left broad ligament seen during the sonographic examination which could not be confirmed during surgery. All other sonographic findings in #Enzian compartments FB, FI, FU, and FO were correct.

The sensitivities and specificities for the detection of the presence of endometriotic lesions by preoperative TVS in each #Enzian compartment with the respective 95 % CIs, considering only the presence or absence of a lesion irrespective of the severity grade of the lesion, are shown in ► **Table 5**. For #Enzian compartment T, it was not possible to calculate sensitivities and specificities, as there were too few cases without any lesion during TVS or surgery (there were only 2 women without any adhesions in compartment

B left and 6 women without adhesions in compartment B right; all other women presented with adhesions of varying severity grades).

Discussion

This study shows that preoperative TVS can accurately predict the location and size of DE lesions. In #Enzian compartments A, B, and C, more than 80 % of all cases lay within a maximum tolerance margin of 3 mm for the TVS measurements, reflecting a clinically negligible difference in particular for large DE lesions. Confirming previous findings [8], #Enzian compartment C (rectum) showed the highest rate (74 %) of exact concordance, i. e., the measurement by TVS matched exactly the evaluation during surgery. For #Enzian compartment A (vagina, retrocervical area, and rectovaginal septum) and in particular for #Enzian compartment B (uterosacral ligaments and parametria), the rates of exact concordance were slightly lower (for example, 55 % for B left and 60 % for B right), possibly because it may be difficult to differentiate fibrotic tissue surrounding the DE lesion from the actual DE lesion during both TVS and surgery in some cases. However, when a maximum tolerance margin of 3 mm was considered, a rate of 88 % for each side could be observed for compartment B, reaching the values seen for compartment C.

Regarding #Enzian compartment O (ovary), the exact evaluation of the lesion size might be particularly difficult during surgery. Endometriotic cysts are spherical and located inside the ovary. It is not uncommon for the cyst to be opened when the ovary is mobilized, and the next cyst is opened after aspiration of the contents. A direct measurement of the dimensions is therefore more difficult. Furthermore, in the case of the presence of more than one cyst in the same ovary, the maximal diameters of all cysts have to be assessed to get the sum of the diameters, which determines the severity grade. For these reasons, compared to #Enzian compartments A, B and C, the differences between TVS and surgery are accordingly greater. However, greater differences may not be as clinically relevant in the case of ovarian cysts as they are for endometriotic lesions in other #Enzian compartments.

In #Enzian compartment T, subjective evaluation of the severity grade of the observed adhesions might play a role to a certain extent during both TVS and surgery, in particular for moderate adhesions (corresponding to #Enzian T2). However, in the presence of severe adhesions (#Enzian T3) or slight adhesions (#Enzian T1), TVS and surgery showed a high rate of concordance (86 % of TVS T3 on the left, 84 % of TVS T3 on the right, as well as 75 % of TVS T1 on the left and 77 % of TVS T1 on the right side confirmed by surgery). Therefore, severe adhesions seen on TVS are really severe or at least moderate, and slight or absent adhesions on TVS do not turn out to be moderate or severe, thus allowing for an adequate preoperative assessment of the anticipated surgical complexity regarding tubo-ovarian adhesions.

When comparing the lesion sizes in compartments A, B, C, and O using the severity grades of the #Enzian classification, similar results are obtained. The concordance rates were slightly lower because discordant measurements during TVS and surgery often differ by only a few millimeters but the two measurements belong to two adjacent severity grades. For example, a 9 mm lesion on

► **Table 5** Sensitivities and specificities for the detection of endometriotic lesions in different #Enzian compartments by preoperative sonographic examination.

#Enzian compartment	Sensitivity (95 % CI ^a)	Specificity (95 % CI ^a)
#Enzian FB (urinary bladder)	86 % (42 %-100 %)	100 % (96 %-100 %)
#Enzian FI (other intestinal locations)	100 % (80 %-100 %)	100 % (95 %-100 %)
#Enzian FU (ureters)	100 % (75 %-100 %)	100 % (95 %-100 %)
#Enzian FO (other location)	100 % (48 %-100 %)	98 % (92 %-100 %)
#Enzian A (vagina, retrocervical area, RVS ^b)	97 % (90 %-100 %)	86 % (64 %-97 %)
#Enzian B left (left USLs ^c , left parametria)	97 % (90 %-100 %)	70 % (47 %-87 %)
#Enzian B right (right USLs ^c , right parametria)	100 % (95 %-100 %)	90 % (70 %-99 %)
#Enzian C (rectum)	100 % (92 %-100 %)	96 % (86 %-100 %)
#Enzian O left (left ovary)	100 % (91 %-100 %)	96 % (87 %-100 %)
#Enzian O right (right ovary)	100 % (87 %-100 %)	100 % (94 %-100 %)

^aCI – confidence interval; ^bRVS – rectovaginal septum, ^cUSLs – uterosacral ligaments

TVS will be classified as A1, but if it is 10 mm during surgery it will be classified as A2. This happens when measurements are very close to 10 mm or 30 mm which are the limits between the different severity grades. This can be seen most frequently for #Enzian compartments A and B, where lesions are more often around 10 mm in size.

For #Enzian compartment FB (urinary bladder), all DE lesions seen on TVS were confirmed by surgery, corresponding to a false-positive rate of 0% and a specificity of 100%. Only one DE lesion was not detected by TVS, leading to a sensitivity of 86%. The only missed lesion was an anterior nodule located between the urinary bladder and the anterior abdominal wall measuring 10 mm in diameter. In #Enzian compartment FO there were only two discordant findings: a lesion at the level of the umbilicus and another one in the left broad ligament, which were seen during sonographic examination but could not be confirmed by surgery. All other sonographic findings in #Enzian compartments FB and FO were correct. In #Enzian compartments FI and FU, all sonographic findings were confirmed by surgery (resulting in a sensitivity and specificity of 100% for both compartments).

Despite the fact that the retrospective design might be considered a limitation of this study, there were no missing data, and the comparison of different lesion sizes could be carried out seamlessly. As a second limitation, the study uses the findings of a tertiary referral center with an expert in gynecological sonography and experienced surgeons. Therefore, the results may not be generally applicable to everyday clinical practice. Thirdly, in the clinical setting of this study, the surgeon was not blinded regarding the preoperative TVS evaluation. This may include a possible bias, as some lesions in certain #Enzian compartments (mainly FI and FO) might only have been detected during surgery because of the knowledge of their presence gained by preoperative sonographic examination. On the other hand, this reflects real everyday clinical practice, and it would have to be considered unethical and harmful for the patient to leave some DE lesions because they were missed during surgery due to blinding of the surgeon to the preoperative TVS.

In conclusion, the present study shows that preoperative evaluation of the location and size of DE lesions in different #Enzian compartments by an expert in gynecological sonography is very

accurate, thereby providing the surgeon with a detailed depiction of the extent of the disease that will be encountered during surgery. Furthermore, by comparing the lesion sizes between TVS and surgery using the #Enzian severity grades, it is the first study to show that the new #Enzian classification can be applied to describe disease extent during both TVS and surgery, thereby offering a descriptive system for both noninvasive and invasive specialties.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

- [1] Chapron C, Dubuisson JB. Management of deep endometriosis. *Ann N Y Acad Sci* 2001; 943: 276–280. doi:10.1016/s1297-9589(03)00045-6
- [2] Koninckx PR, Meuleman C, Demeyere S et al. Suggestive evidence that pelvic endometriosis is a progressive disease, whereas deeply infiltrating endometriosis is associated with pelvic pain. *Fertil Steril* 1991; 55: 759–765. doi:10.1016/s0015-0282(16)54244-7
- [3] Fedele L, Bianchi S, Raffaelli R et al. Pre-operative assessment of bladder endometriosis. *Hum Reprod* 1997; 12: 2519–2522. doi:10.1093/humrep/12.11.2519
- [4] Keckstein J, Wiesinger H. Deep endometriosis, including intestinal involvement – the interdisciplinary approach. *Minim Invasive Ther Allied Technol* 2005; 14: 160–166. doi:10.1080/14017430510035916
- [5] Keckstein J, Ulrich U, Possover M et al. ENZIAN-Klassifikation der tief infiltrierenden Endometriose. *Zentralbl Gynakol* 2003; 125: 291
- [6] Keckstein J, Saridogan E, Ulrich UA et al. The #Enzian classification: A comprehensive non-invasive and surgical description system for endometriosis. *Acta Obstet Gynecol Scand* 2021. doi:10.1111/aogs.14099
- [7] Guerriero S, Condous G, van den Bosch T et al. Systematic approach to sonographic evaluation of the pelvis in women with suspected endometriosis, including terms, definitions and measurements: a consensus opinion from the International Deep Endometriosis Analysis (IDEA) group. *Ultrasound Obstet Gynecol* 2016; 48: 318–332. doi:10.1002/uog.15955
- [8] Hudelist G, Montanari E, Salama M et al. Comparison between Sonography-based and Surgical Extent of Deep Endometriosis Using the Enzian Classification – A Prospective Diagnostic Accuracy Study. *J Minim Invasive Gynecol* 2021. doi:10.1016/j.jmig.2021.02.009