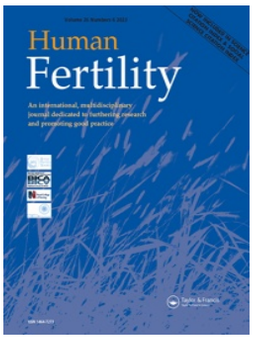

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RESEARCH ARTICLE

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Characterising umbilical abdominal wall endometriosis as a distinct subgroup of abdominal wall endometriosis – retrospective cohort study

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ABSTRACT

Abdominal wall endometriosis (AWE) is one of the rarest forms of endometriosis. Little is known about differences between umbilical AWE (U-AWE) and non-umbilical AWE (non-U-AWE) patients. This retrospective cohort study included patients treated for AWE at tertiary endometriosis centre between 2012 and 2020. Patients were divided into two groups – umbilical AWE and non-umbilical AWE.

We identified 14 U-AWE and 45 non-U-AWE patients who mostly had lesions in caesarean section scar (38, 64.4%), rarely at other locations (7, 11.9%). Infertility rates for U-AWE patients and non-U-AWE patients were 57.1% and 17.8%, respectively. Concurrent or previous peritoneal endometriosis was noted in 85.7% of U-AWE and 24.4% of non-U- AWE patients. In addition, U-AWE patients and non-UAWE patients significantly differed in following: parity, number of previous caesarean sections, lesion size, prevalence of concurrent or previous deep infiltrating endometriosis, bleeding from abdominal wall, cyclic pain, continuous pain.

Infertility and pelvic endometriosis were more prevalent in U-AWE patients. Our data suggests that U-AWE may be a specific marker for a patient highly prone to pelvic endometriosis and subsequent infertility. Findings suggests that clinician should consider comprehensive evaluation of U-AWE patients.

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Abdominal wall endometriosis; umbilical endometriosis; caesarean section; pelvic endometriosis; peritoneal endometriosis; deep infiltrating endometriosis; infertility

Introduction

Endometriosis is a common disorder affecting approximately 10% of women of reproductive age (Zondervan et al., 2020). It is an oestrogen-dependent chronic inflammatory condition, defined by the presence of endometrial glands and stroma outside the uterine cavity. It most commonly affects the pelvic peritoneum, ovaries, and rectovaginal septum; it can also be found in the bladder, bowel, deep pelvic nerves, ureters, anterior abdominal wall, abdominal skin, diaphragm, pleura, lungs, pericardium, and brain (Bulun et al., 2019; Giudice, 2010; Vercellini et al., 2014). This complex condition is one of the main causes of chronic pelvic pain in women, as well as dysmenorrhoea, dyspareunia infertility, constipation and/or diarrhoea, painful defaecation and/or urination, heavy menstrual bleeding, fatigue and depression and infertility (Bulun et al., 2019; Saunders & Horne, 2021).

Abdominal wall endometriosis (AWE) is one of the rare forms of endometriosis. AWE predominantly follows an obstetric or gynaecological procedure, the primary cause being caesarean sections (c.s. AWE), comprising up to 85% of AWE by some authors. Other surgeries include hysterotomy, hysterectomy, and laparoscopic procedures (Carsote et al., 2020; Lopez-Soto et al., 2018).

AWE has also been reported in women with no surgical history. AWE has also been found in the other abdominal wall locations such as the inguinal region (Kyamidis et al., 2011).

The pathogenesis of the condition is still a widely discussed topic with no theory explaining it fully. It seems to include endocrine, immune, and inflammatory mechanisms. The implantation theory partly explains scar endometriosis proposing a direct implantation of endometrial cells into the incision during surgery. With the combination of sufficient nutrients and hormonal stimuli, the cells can survive

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and proliferate, causing AWE. This, however, does not explain the low incidence of caesarean scar endometriosis, as well as not being relevant to primary AWE (Alnafisah et al., 2018; Carsote et al., 2020; Zhang et al., 2019). Other theories include retrograde menstruation (the Sampson hypothesis), the coelomic metaplasia theory, embryonic rest theory, lymphovascular metastasis theories, and the composite theory – a combination of the before mentioned theories (Blanco et al., 2003; Ghosh & Das, 2014; Sasson & Taylor, 2008).

A typical patient with AWE is a woman of reproductive age who presents with a mass or nodule, pain, and has a history of gynaecological surgery. The onset of symptoms following surgery has a large interval, starting from 3 months to 10 years. The pain is typically described as cyclical, that is associated with menstruation (Azhar et al., 2019; Blanco et al., 2003; Carsote et al., 2020; Gonzalez et al., 2021; Horton et al., 2008; Lopez-Soto et al., 2018; Vellido-Cotelo et al., 2015; Zhang et al., 2019).

However, Horton et al. showed that only 57% of patients presented with cyclic symptoms (Horton et al., 2008). Other symptoms include bleeding from the mass, lower abdominal pain, and growing of the mass during menstruation (Horton et al., 2008; Lopez-Soto et al., 2018; Vellido-Cotelo et al., 2015). Rarely there are skin changes, ecchymosis during menstruation or hyperpigmentation of the scar (Alnafisah et al., 2018; Carsote et al., 2020). In up to 80% of cases the women can be completely asymptomatic (Lopez-Soto et al., 2018; Omori et al., 2014). Most women present with a solitary lesion, though rare cases of multiple lesions have been described (Zhang et al., 2019).

The data on the concurrence of pelvic endometriosis in women with AWE is split, with some saying that the incidence is within the same range as in all women of reproductive age (Blanco et al., 2003; Horton et al., 2008; Vellido-Cotelo et al., 2015) and others recording a higher incidence with a range from 15% to 25% (Blanco et al., 2003; Chatterjee, 1980; Gin et al., 2013; Lopez-Soto et al., 2018).

The differential diagnosis consists of a wide spectrum of pathologies and includes infections at the scar site, hernia, haematoma, keloid, lymphadenopathy, lymphoma, lipoma, abscess, subcutaneous cyst, suture granuloma, neuroma, soft-tissue sarcoma, desmoid tumours and metastatic cancer. There is a high rate of misdiagnoses due to the rarity of abdominal wall endometriosis and the wide range of differentials (Blanco et al., 2003; Gonzalez et al., 2021; Horton et al., 2008; Lopez-Soto et al., 2018). Malignant transformation of scar endometriosis is a rare occurrence, Shalin et al. suggests an estimated incidence of no more than 0.3–1.0%, typically histology is clear cell or endometrioid carcinoma (Shalin et al., 2012).

The diagnosis of scar endometriosis is made clinically if classical clinical signs are present. Ultrasound, CT or MRI are non-invasive diagnostic methods but are often inconclusive. Definitive diagnosis is histological, however fine-needle cytological biopsy frequently provides strong suggestion (Gonzalez et al., 2021; Lopez-Soto et al., 2018).

The treatment of choice is a wide local excision of the mass with negative margins (Blanco et al., 2003; Horton et al., 2008; Lopez-Soto et al., 2018; Morales Martínez & Tejuca Somoano, 2017).

The reported rate of recurrence is between 1.5% and 11% with most of the reviewed studies reporting a recurrence rate closer to the higher end of the range (Blanco et al., 2003; Horton et al., 2008; Lopez-Soto et al., 2018).

Umbilical endometriosis (U-AWE), also termed Villar's nodule, is defined as the presence of endometrial glands or stroma within the umbilicus. It is clinically characterised by coloured (red or blue) umbilical lesion. Most women with U-AWE presented with symptoms – cyclical swelling (80%–91%), pain (around 80%) or bleeding (45–50%) from umbilicus (Dridi, Buggio, et al., 2022; Dridi, Chiaffarino, et al., 2022; Hirata et al., 2020; Victory et al., 2007).

It is a rare form of endometriosis, based on a recent review and monocentric retrospective study, 287 cases were described to date (Dridi, Buggio, et al., 2022; Dridi, Chiaffarino, et al., 2022). Most U-AWE cases were commonly reported in case series or studies on AWE, in contrast to standalone series or studies. In former, U-AWE represented between 3% and 40% (21% according to most recent review) of AWE cases (Dridi et al., 2022; Fancellu et al., 2013; Ghosh & Das, 2014; Michowitz et al., 1983; Pramanik et al., 2014; Victory et al., 2007).

The prevailing belief that umbilical endometriosis develops post-laparoscopy remains widespread, although not supported by studies. Notably, 48% to 69% of U-AWE cases occurred in patients without a history of prior abdominal surgery (Dridi, Buggio, et al., 2022; Dridi, Chiaffarino, et al., 2022; Hirata et al., 2020; Victory et al., 2007).

When examining the incidence of concurrent or previous pelvic endometriosis, earlier studies indicated a lower prevalence, up to 15%. However, recent studies have observed a higher prevalence, with up to 38% of U-AWE patients having a history of pelvic

endometriosis. Classification of the term pelvic as to peritoneal or deep endometriosis has not been reported in most cases (Dridi, Buggio, et al., 2022; Dridi, Chiaffarino, et al., 2022; Hirata et al., 2020; Victory et al., 2007).

As described above, most reports on U-AWE are case series or retrospective studies, with majority being reported within a series on AWE. To our knowledge, no study comprehensively comparing characteristics of U-AWE and non-U-AWE patients has been published. Furthermore, infertility among U-AWE patients has not been explored previously. Our work aims to fill this knowledge gap, by retrospectively identifying and characterising patients in these two subgroups. Specifically, we aim to compare reproductive and surgical history, symptomatology and infertility, association with other forms of endometriosis and AWE treatments specifics.

Methods

Patient identification and data collection

We included all patients treated for abdominal wall endometriosis between 2012 and 2020 at the Department of Reproduction of Gynaecological Division of University Medical Centre Ljubljana, Slovenia. Cases were identified from the database of surgical procedures done between and including 2012 and 2020. We searched for procedures where abdominal wall endometriosis excision was the main procedure or one of the procedures in a tertiary-level endometriosis centre. Upon identification of the patients that underwent abdominal wall endometriosis procedures, we did retrospective chart review, extracting the values of variables described. Anonymised patient data was collected in a table further used in analysis. Requirement of IRB approval was waived due to the nature of the study which consisted of retrospective analysis of anonymised electronic medical record data.

Patient characterization

Patients were characterised by several variables known at the time of the procedure. Reproductive history consisted of number of deliveries, miscarriages and termination of pregnancies. Clinical presentation was characterised by the presence of the following: continuous pain at the lesion site, cyclical pain at the lesion site, cyclical swelling/change in size of the lesion, bleeding from the lesion, other endometriosis related symptoms (dysmenorrhoea, dyspareunia, fatigue, chronic pelvic pain, cyclical pelvic pain). History or presence of infertility was evaluated from preoperative patient-provided history and from patient medical records. History of previous abdominal surgical procedures was summarised with number of caesarean sections, horizontal laparotomies for other procedures than c.s., vertical laparotomies for procedures other than c.s., other laparotomies (e.g. McBurney for appendectomy), laparoscopies. Presence and history of pelvic endometriosis was determined by the number of treatment session for ovarian endometriomas, peritoneal endometriosis, deep infiltrating endometriosis and whether hysterectomy had been done. AWE treatments specifics were described by number of AWE treatments, total number of excised lesions, size of the biggest lesion, location of the lesion.

Statistical analysis

Variables were summarised with appropriate statistical measures, depending on the type – median with the range for continuous variables and frequencies for categorical variables.

Between-subgroup analysis was done using Fisher's exact test for categorical variables and non-parametric Mann-Whitney U test for continuous variables due to non-normal distribution, as determined with Shapiro-Wilk test. Two-sided statistical tests were used with a level of significance of 0.05. IBM SPSS Statistics 27.0 (IBM Corporation, Armonk, NY, USA) was used for statistical analyses.

Specific information was also extracted by analysing the dataset directly, which was possible due to manageable size.

Results

Within the database that contained 12,117 procedures, we identified 59 (0.5%) patients that underwent excision of abdominal wall endometriosis as a main or additional procedure. These constituted our study group.

AWE patients

Clinical characteristics of patients treated for AWE are presented in Table 1. Median age of patents was 35 years, with the youngest being 22 years and the oldest 49. Majority of patients (43, 72.9%) had 1 or more prior caesarean section (c.s.). Eight (13.6%) patients had other prior laparotomies. Previous laparoscopies were more common −12 (20.3%) patients previously underwent one laparoscopy procedure and

Table 1. Characteristics of patients treated for abdominal wall endometriosis and comparison between umbilical AWE and non-umbilical AWE patients.

Feature		Measure/category	All patients $N = 59$	Non-umbilical AWE patients $N = 45$	Umbilical AWE patients $N = 14$	non-U-AWE vs. U-AWE[b]
Age		Years – median (min-max)	35 (22–49)	35 (22–49)	32 (27–41)	0.225[c]
		Years – mean	34.7	35.2	33.3	0.218[c]
Reproductive history						
Deliveries	All patients	*N-median (min-max)*	*1 (0–4)*	1 (0–4)	0 (0–2)	**<0.001[c]**
	0	*N* (%)	12 (20.3)			
	1	*N* (%)	28 (47.5)			
	>=2	*N* (%)	19 (32.2)			
TOPs/miscarriages	All patients	*N-median (min-max)*	*0 (0–2)*	0 (0–2)	0 (0–2)	0.508[c]
	0	*N* (%)	42 (71.2)			
	1	*N* (%)	12 (20.3)			
	2	*N* (%)	5 (8.5)			
Clinical presentation						
Continuous pain		*N* (%)	20 (33.9)	20 (44.4)	0 (0.0)	**0.001[d]**
Cyclic pain		*N* (%)	30 (50.8)	27 (60.0)	3 (21.4)	**0.015[d]**
Cyclic lesion swelling		*N* (%)	7 (11.9)	6 (13.3)	1 (7.1)	1.000[d]
Bleeding from abdominal wall		N (%)	10 (16.9)	1 (2.2)	9 (64.3)	**<0.001[d]**
Other endometriosis related symptoms		*N* (%)	25 (42.4)	20 (44.4)	5 (35.7)	0.758[d]
Infertility		*N* (%)	16 (27.1)	8 (17.8)	8 (57.1)	**0.013[d]**
History of previous abdominal surgical procedures						
C.s.	All patients	*N-median (min-max)*	*1 (0–2)*	1 (0–2)	0 (0–1)	**<0.001[c]**
	0	*N* (%)	16 (27.1)	3 (6.7)	13 (92.9)	
	1	*N* (%)	32 (54.2)	31 (68.9)	1 (7.1)	
	2	*N* (%)	11 (18.6)	11 (24.4)	0 (0.0)	
Other laparatomies		*N* (%)	2 (3.4)	1 (2.2)	1 (7.1)	0.421[d]
Horizontal laparatomy		*N* (%)	3 (5.1)	1 (2.2)	2 (14.3)	0.137[d]
Midline laparatomy		*N* (%)	3 (5.1)	2 (4.4)	1 (7.1)	0.564[d]
Laparascopy	All patients	*N-median (min-max)*	*0 (0–5)*	0 (0–5)	0 (0–2)	0.201[c]
	0	*N* (%)	42 (71.2)	34 (75.6)	8 (57.1)	
	1	*N* (%)	12 (20.3)	8 (17.8)	4 (28.6)	
	>=2	*N* (%)	5 (8.5)	3 (6.7)	2 (14.3)	
AWE treatment specifics						
AWE treatments	All patients	*N-median (min-max)*	*1 (1–3)*	1 (1–3)	1 (1–3)	**0.034[c]**
	1	*N* (%)	49 (83.1)	40 (88.9)	9 (64.3)	
	2	*N* (%)	8 (13.6)	5 (11.1)	5 (35.7)	
	>=3	*N* (%)	2 (3.4)	2 (4.4)	0 (0)	
AWE lesions excised	All patients	*N-median (min-max)*	*1 (1–4)*	1 (1–4)	1 (1–3)	0.175[c]
	1	*N* (%)	46 (78.0)	37 (82.2)	9 (64.3)	
	2	*N* (%)	10 (16.9)	6 (13.3)	4 (28.6)	
	>=3	*N* (%)	3 (5.1)	2 (4.4)	1 (7.1)	
Biggest lesion size[a]		Centimeters – median (min-max)	2 (0.5–5.5)	2.5 (0.5–5.5)	1.0 (0.7–3.0)	**0.001[c]**
Lesion location	C.s. scar	*N* (%)	38 (64.5)	38 (84.4)	0	
	Umbilicus	*N* (%)	14 (23.7)	0 (0)	14	
	Midline laparatomy	*N* (%)	1 (1.6)	1 (2.2)	0 (0)	
	Other	*N* (%)	6 (10.2)	6 (13.3)	0 (0)	
Concurrent or previous pelvic endometriosis treatment						
Ovarian endometrioma treatment		*N* (%)	11 (18.6)	6 (13.3)	5 (35.7)	0.110[d]
Peritoneal endometriosis treatment		*N* (%)	23 (39.0)	11 (24.4)	12 (85.7)	**<0.001[d]**
DIE treatment		*N* (%)	6 (10.2)	1 (2.2)	5 (35.7)	**0.002[d]**
Hysterectomy		*N* (%)	2 (3.4)	2 (4.4)	0 (0.0)	1.000[d]

TOPs – terminations of pregnancy, C.s. – cesarean section, N.o. – number, DIE – deep infiltrating endometriosis, [a] – Missing data for 4 patients in U-AWE group (28.6%) and 8 in non-U-AWE group (17.7%), [b] – *p*-values of comparisons between non-U-AWE and U-AWE patients, significant values are in bold, [c] – Fisher's exact test for categorical variables, [d] – non-parametric Mann-Whitney U test for continuous variables.

5 (8.5%) patients underwent two or more. Patients most commonly presented with cyclical pain, reported by half of patients, continuous pain and other endometriosis related symptoms (dyspareunia, dysmenorrhoea, chronic pelvic pain) which were reported by nearly half of the patients. 16 (27.1%) patients had a history of infertility.

Most patients (43, 72.2%) were treated for AWE only once. In a small number of procedures (4, 6.7%) more than one AWE lesion was excised. Lesion size

varied between 0.5 and 5.5 centimetres. 38 (64.4%) patients were treated for c.s. AWE, 14 (23.7%) for umbilical AWE, 7 patients for AWE in other sites. Specifically, 2 patients in the inguinal canal, 1 patient after c.s. had AWE below umbilicus in the midline, 1 patient without previous operations had AWE 2 cm lateral to umbilicus, 1 patient after several laparoscopies had AWE 2 cm below umbilicus in the midline, 2 patients had AWE in scar after appendectomy.

25 (42.3%) patients were concurrently or previously treated for one or several types of pelvic endometriosis – most commonly for peritoneal −23 (39%) and ovarian −11 (18.6%). 6 (10.2%) patients were treated for deep infiltrating endometriosis. Two patients had concurrent or previous hysterectomy.

U-AWE vs. non-U-AWE patients

We split the patients into two subgroups – patients with umbilical endometriosis (U-AWE patients) and patients without umbilical endometriosis (non-U-AWE patients). We compared their clinical characteristics (Table 1). U-AWE patients were of lower parity ($p < 0.001$), only one patient had previous caesarean section ($p < 0.001$), they were of younger age (32 years vs. 35 years), although the difference was not significant ($p = 0.225$). They clinically presented differently – less commonly with cyclical pain (21% vs 60%, $p = 0.001$) and continuous pain (0% vs 44%, $p = 0.015$) and more commonly with bleeding at the lesion site (64% vs 2%, $p < 0.001$). Infertility was more prevalent in this subgroup (57% vs. 18% $p = 0.013$). U-AWE patients were more frequently operated on for endometriosis in general, especially peritoneal endometriosis (86% vs 24%, $p < 0.001$), as well as deep infiltrating endometriosis (36% vs 2.2%). However, history of previous laparoscopy was not more prevalent in patients with umbilical endometriosis compared to others (43% vs. 24.5%, $p = 0.201$). U-AWE patients were more frequently re-operated for AWE (36% vs. 11%, $p = 0.001$). On the contrary, their lesions were smaller (1 cm vs. 2.5 cm, $p = 0.001$).

Discussion

Analysis of the presented case series confirms several findings from previous works: AWE is a rare entity, most common site is caesarean scar, most common symptom is pain, either continuous or cyclical (Carsote et al., 2020; Lopez-Soto et al., 2018). Compared to previous descriptions, lesions more frequently recurred (Blanco et al., 2003; Chatterjee, 1980; Gin et al., 2013; Horton et al., 2008; Lopez-Soto et al., 2018; Vellido-Cotelo et al., 2015). Concurrent pelvic endometriosis (peritoneal, DIE) was more prevalent in patients with AWE in our series, compared to the general population. As mentioned in the review, this is in line with some previous studies, but not all (Blanco et al., 2003; Chatterjee, 1980; Gin et al., 2013; Horton et al., 2008; Lopez-Soto et al., 2018; Vellido-Cotelo et al., 2015). Probable explanation is that we analysed data from endometriosis centre where endometriosis related symptoms and signs are actively searched for, contrary to case series from departments operated by non-endometriosis surgeons (Boesgaard-Kjer et al., 2017).

Almost one third of patients in our series had a history of infertility, which is higher than in the general population. To our knowledge, no study on AWE previously reported infertility rates.

However, these general findings only hold true when patients with all subtypes of AWE are pooled together. Small proportion of patients in our series had U-AWE and even smaller AWE in other unusual locations (inguinal canal and other sites). Comparing patients with U-AWE to the remaining group (mainly consisting of caesarean scar AWE patients) unravels striking differences in characteristics of these patients. Frequency of U-AWE in our study was 23.7%, in the range of previously reported frequencies. Our U-AWE patients were (although non-significantly) younger than others with AWE. Previous studies reported mean ages between 31 and 37 years, the range which contains our result (Patterson & Winburn, 1999; Steck & Helwig, 1965; Victory et al., 2007). U-AWE endometriosis patients, in comparison to non-U-AWE patients, were more prone to suffer from peritoneal and deep infiltrating endometriosis, with rates of 86% and 36%, compared to 24% and 2.2% respectively. According to our knowledge, no previous study compared U-AWE to non-U-AWE patients in this regard. Strikingly higher incidence in our study (compared to 38% in latest review), similarly to higher incidence in whole group is probably due to the same fact – patients were treated in endometriosis centre, where endometriosis related symptoms and signs are actively searched for (Dridi, Chiaffarino, et al., 2022). Due to higher rate of previous or concurrent diagnostic laparoscopy, we believe that presented data is more accurate in this regard.

In our study, U-AWE patients presented with smaller lesion sizes than others. However, lesions significantly more frequently relapsed. This is contrary to findings of a recent meta-analysis, which reports a recurrence rate of 4.7% (Dridi, Chiaffarino, et al., 2022). The difference may be due to the fact that some

patients were treated at our centre for reccurence after being operated at general gynaecological or surgical department where non-radical excision may have been performed.

According to our data, most of U-AWE patients had not undergone previous caesarean section or other abdominal surgery via laparotomy (Dridi, Chiaffarino, et al., 2022). History of previous laparoscopy was more common in patients with umbilical AWE, at 43%, compared to 24.4% in others, although non-significant. Recent meta-analysis reports rates of previous abdominal surgery at 31%, albeit with no distinction between laparoscopic or laparotomic route (Dridi, Chiaffarino, et al., 2022). Our data partly supports previous studies and further refutes misconception that U-AWE develops mainly after laparascopy (Victory et al., 2007).

Retrospective observational nature of the presented study introduces several potential limitations by design. However, due to excellent data collection into registry at the time of treatment, there was no need for contacting the patients retrospectively. Therefore, we observed missing values only for one variable (lesion size) in 13 patients. Study design precludes conclusions on potential causality; however this was not among the aims of the study. Major limitation is the number of patients, especially U-AWE patients, which was rather small (14), making several comparisons under-powered. Therefore, caution should be exercised in interpreting our results, which primarily serve as a basis for future research.

U-AWE is an entirely different clinical entity compared to caesarean scar AWE, with probable different etiopathogenesis (Dridi, Chiaffarino, et al., 2022). Specifically, postulated theories of U-AWE were: 1) metaplastic changes of urachal remnants – coelomic metaplasia theory, 2) embryonic rest theory 3) metastasis via venous or lymph vessels – lymphovascular theory and 4) transtubal menstrual reflux, so-called retrograde menstruation – Sampson theory (Blanco et al., 2003; Dridi, Chiaffarino, et al., 2022; Ghosh & Das, 2014; Sasson & Taylor, 2008). Recently Dridi and others argued that Sampson theory of retrograde menstruation may suffice to explain U-AWE. As proposed, endometrial cells from retrograde menstruation travel with peritoneal fluid from pelvis along right paracolic gutter to upper abdominal quadrants and along ligamentum teres hepatis towards the umbilicus. They support the hypothesis with high rates of concurrent pelvic endometriosis in U-AWE patients and high rates of U-AWE without history of previous surgery and liken this theory to the mechanism of peritoneal spread in ovarian cancer (Dridi, Buggio, et al., 2022; Dridi, Chiaffarino, et al., 2022). Our data, with a high incidence of concurrent or previous pelvic endometriosis and low rate of previous abdominal surgery in U-AWE patients, supports Sampson theory.

Conclusion

High prevalence of concurrent or previous peritoneal and deep infiltrating endometriosis as well as infertility in our cohort of U-AWE patients suggests that umbilical endometriosis may be a specific marker for a patient highly prone to pelvic endometriosis and subsequent infertility.

Frequent co-occurrence with pelvic endometriosis, supported by this study, suggests that clinician should consider comprehensive evaluation of these patients which may include expert US assessment, other imaging modalities and diagnostic laparoscopy and treatment.

The findings shed new light also on the results of previous studies that pooled both of these subgroups together, as many characteristics of these two patient groups are different. Further clinical studies in larger cohorts are needed to differentiate these two patient groups clearly, characterise and analyse them separately with reporting of infertility rates.

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Author contributions

Conceptualisation – BP, EBV, EV; Methodology – BP, EBV, EV; Writing—original draft preparation – BP, EV; Writing—review and editing – BP, EV, EBV; Visualisation – BP; Supervision – EBV; Funding acquisition – EBV. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors report no conflict of interest

Informed consent statement

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Institutional review board statement

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Data availability statement

All data generated or analysed during this study are included in this published article.

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