Clinical and Experimental Obstetrics & Gynecology

Clin. Exp. Obstet. Gynecol. **2025**; 52(2): 26272
https://doi.org/10.31083/CEOG26272

Original Research

Do Interventions on the Uterine Wall Increase the Risk of Developing Abdominal Wall Endometrioma?

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Academic Editor: Andrea Tinelli
Submitted: 26 August 2024 Revised: 12 December 2024 Accepted: 16 December 2024 Published: 5 February 2025

Abstract

Background: Abdominal wall endometriosis, which can affect the rectus abdominis muscle, has been documented in association with cesarean section scars or along pathways formed by abdominopelvic surgeries. Our study aimed to assess the risk of developing abdominal wall endometriomas following surgical interventions (cesarean section, myomectomy) on the uterine wall. **Methods**: Between 2011 and 2021, a total of 19,574 patients underwent cesarean section delivery through a Pfannenstiel incision. The average age of patients was 36 (20–58) years. On average, 1.5 to 2.0 years after cesarean section, 204 patients developed abdominal wall endometrioma (Group I). The control group (Group II) comprised 204 patients who had undergone cesarean section by the same method but did not develop scar endometriosis. During the same period, 200 patients underwent myomectomy with a similar incision for intramural and submucosal myomas (Group III). Postoperatively, these patients were also monitored for the development of endometrioma. One of the patients who underwent myomectomy also had surgery for an ectopic pregnancy at the same time. The data analysis included descriptive statistical methods, such as calculating the mean ± standard deviation, median (min–max), and frequencies (n (%)). The Shapiro-Wilk normality test, Kruskal-Wallis test, Dunn's multiple comparison test, Chi-Square test, and Fisher-Freeman-Halton exact test were applied. The results were evaluated for statistical significance at a level of $p < 0.05$. **Results**: Abdominal wall endometriomas developed in 204 of 19,574 patients who delivered by cesarean section (1.04%). Endometrioma development was significantly higher in Group I, where estrogen levels were elevated ($p < 0.001$). The most common complaints among the patients were swelling and cyclical pain in the abdominal wall. 9 of the 204 patients who had previously developed abdominal wall endometriomas experienced recurrence (4.41%). An abdominal wall endometrioma developed in the patient who underwent myomectomy and surgery for ectopic pregnancy simultaneously (0.5%). **Conclusions**: Endometrioma is a multifactorial condition. High estrogen levels, surgical techniques, and an increased imbalance between estrogen and progesterone levels can trigger inflammation and lead to the development of endometriomas. We suggest that further detailed studies are needed to better understand these mechanisms.

Keywords: abdominal wall endometrioma; section; intramural myoma; submucous myoma; recurrence

1. Introduction

Endometriosis is a medical condition in which tissue similar to the lining of the uterus, the endometrium, begins to grow outside the uterus. This can occur on the ovaries, fallopian tubes, the outer surface of the uterus, and other organs within the pelvic cavity. It can cause various symptoms such as pelvic pain, painful periods, and infertility. Endometriosis impacts around 15% to 40% of women in their childbearing years, typically occurring within the abdominal cavity, particularly in the pelvis, and sometimes in locations outside of the pelvis [1]. Previous surgical procedures, such as cesarean sections or hysterectomies, can lead to this condition. Abdominal wall endometrioma (AWE), also known as extrauterine endometriosis or scar endometriosis, is a rare condition where endometrial tissue is found in the subcutaneous fatty layer or muscles of the abdominal wall. AWE typically occurs due to the spread of endometrial tissue at the incision site during obstetrical or gynecological surgeries. This can occur as a result of previous surgical procedures, such as cesarean sections or hysterectomies, or from other abdominal surgeries [2,3]. The incidence of scar endometriosis following a cesarean section is estimated to be around 0.03% to 1% [4–6]. The typical symptoms of this condition may involve discomfort, puffiness, and the observation of a bump or growth near the scar area. This ailment commonly affects women aged between 24 and 47 years [4].

There are 2 main theories proposed for the development of scar endometriosis: the cellular transport theory and the coelomic metaplasia theory. The cellular transport theory suggests that endometrial cells are transported to different areas of the body through various channels such as lymphatic vessels, blood vessels, or surgical procedures, where they implant and grow, leading to the development of scar endometriosis. The coelomic metaplasia theory suggests that cells resembling endometrial tissue can undergo a transformation from the lining of the abdominal cavity (coelomic epithelium) in response to hormonal or inflam-

matory stimuli, leading to the formation of scar endometriosis. Both theories provide explanation for the occurrence of scar endometriosis [5]. Other causes thought to be related to the development of surgical scar endometriosis include hematogenous and lymphatic spread [6]. The precise process underlying the development of scar endometriosis is not completely understood.

Especially during the postpartum period, estrogen levels can be elevated after a cesarean section. The heightened presence of estrogen can potentially affect the endometrium and promote the expansion of endometrial tissue outside the uterus. When it comes to estrogen exposure and the spread of endometrial cells, local growth factors may play a role in the growth and sustenance of these cells beyond the uterus [7–9].

The goal of this study was to determine the frequency and causes of abdominal wall endometrioma developing in the suprapubic transverse Pfannenstiel incision line and rectus abdominis muscle in 19,574 female patients who gave birth by cesarean section between 2011 and 2021 in our health institution and 200 women operated for "intramural and submucous myoma" in the same period.

2. Materials and Methods

The research protocol was approved by Istanbul Medipol University Ethics Committee (E-10840098-772.02-7514). The aim of this study was to determine the frequency and causes of abdominal wall endometrioma after surgical interventions such as cesarean section and myomectomy in cases where the uterine wall was opened. All procedures conducted in the study adhered to ethical principles and followed the guidelines of the Declaration of Helsinki. This study was a single center study conducted retrospectively in 608 cases. Patients who gave birth by cesarean section with and without endometrioma and had myomectomy were included in the group. We did not include patients who had normal births in the study.

Group I; Abdominal wall endometrioma (+) cesarean section patients: 204, Group II; Cesarean section patients without abdominal wall endometrioma: 204 and, Group III; intramural & submucous myomectomy: 200 cases operated by the same general surgeon and gynecologist between 2011 and 2021. After receiving ethics committee approval for the study, symptoms of patients, laboratory tests, radiologic examinations, surgical procedure, intraoperative findings and postoperative complications, and pathology results were evaluated in terms of recurrence and recovery criteria. The inclusion of the cases in the research was to determine abdominal wall endometrioma (n = 204) and intramural + submucous myoma (n = 200) based on clinical findings and radiological imaging (superficial & transvaginal ultrasound). As some of the patients were illiterate, we obtained written consent from their relatives.

All patients underwent thorough questioning and examination in the outpatient department before being individually admitted to the hospital on the day of surgery. The preanesthetic evaluation was conducted by the same anesthesia team for each patient. After the anesthesia, and the surgical area was cleaned of hair, we used an antiseptic cleansing agent, povidone iodine in the surgical field, and 2 preoperative doses of antibiotic were used. All patients were operated on with a transverse Pfannenstiel incision in supine position.

In cases of abdominal wall endometrioma following a cesarean section, a wide excision with a 1-cm margin was performed to minimize the risk of recurrence. The fascia was sutured with 2/0 polydioxanone synthetic (PDS) loop. Out of the 204 patients who underwent surgery for abdominal wall endometrioma, 110 had the endometrioma localized above the rectus abdominis muscle fascia, while 94 had it localized at the level of the rectus abdominis muscle facia. No skin flap was needed to cover the tissue after resection or mesh to repair the fascia defect. After the surgery, the patients' complaints decreased dramatically.

For adenomyotic lesions, the same transverse Pfannenstiel incision was used. Complete excision of intramural and submucous myomas from normal myometrium was performed. Care was taken to avoid unwanted removal of normal myometrial tissues.

During the same period, a control group consisting of 204 patients who did not develop abdominal wall endometrioma clinically and radiologically during at least 1 year of follow-up after giving birth by cesarean section was created.

Statistical Analysis

Statistical analyses for this study were conducted using the NCSS (Number Cruncher Statistical System) 2007 Statistical Software package program from Utah, USA. Descriptive statistics for the variables are presented as mean $\pm$ standard deviation, median (min–max), and frequencies n (%). The normality assumption was tested using the Shapiro-Wilk tests. Group comparisons of continuous variables that did not show normal distribution were tested using the Mann-Whitney U, Kruskal-Wallis tests, and Dunn's multiple comparison test in subgroup comparisons. Categorical data analyses were performed using the Pearson Chi-Square test and the Fisher-Freeman-Halton Exact test, considering the number of categories (rows x columns) and the expected values in crosstab tables cells. The results were evaluated at the significance level of $p < 0.05$.

3. Results

Between 2011 and 2021, 19,574 patients delivered by cesarean section. The average age of patients who underwent cesarean section was 30 (16–52) years. Abdominal wall endometrioma developed in 204 of these patients (Group I) (1.04%), on average 12–18 months after birth. During the same period, 200 patients underwent myomectomy surgery due to intramural and submucous myoma

Table 1. Preoperative laboratory values of the patients.

Variables	Group I (n = 204)	Group II (n = 204)	Group III (n = 200)	p
	Mean ± SD	Mean ± SD	Mean ± SD	
	Median (Min–Max)	Median (Min–Max)	Median (Min–Max)	
Age (year)	31.53 ± 5.92 31.0 (20.0–43.0)	33.64 ± 4.92 34.0 (23.0–44.0)	42.49 ± 4.74 43.0 (31.0–58.0)	<0.001[&]
E2 (pg/mL)	202.03 ± 104.37 188.0 (37.0–396.0)	131.39 ± 103.53 97.0 (30.0–398.0)	180.54 ± 86.75 182.5 (28.0–387.0)	<0.001[&]
Pg (ng/mL)	2.77 ± 3.02 2.0 (0.10–23.0)	3.33 ± 5.23 1.32 (0.10–24.0)	5.79 ± 6.59 3.0 (0.10–32.0)	<0.001[&]
HTC (%)	33.85 ± 2.10 34.0 (27.0–39.0)	34.02 ± 1.88 34.0 (28.0–38.0)	33.05 ± 2.64 33.0 (26.72–40.15)	<0.001[&]
HGB (g/dL)	10.34 ± 0.84 10.0 (8.0–12.30)	10.45 ± 0.70 10.4 (8.5–12.0)	9.83 ± 1.14 10.0 (7.0–12.60)	<0.001[&]
WBC (10^3/mL)	7223.06 ± 1840.47 7195.0 (9.0–10,960.0)	7278.62 ± 1911.86 7320.0 (4485.0–19,885.0)	7100.17 ± 1500.83 6830.0 (4718.0–10,740.0)	<0.001[&]
PLT (10^3/mL)	264.46 ± 61.72 260.0 (135.0–390.0)	244.03 ± 31.00 243.0 (174.0–372.0)	197.44 ± 42.0 197.0 (95.0–320.0)	<0.001[&]
APTT (sec)	29.37 ± 2.41 30.0 (23.0–34.0)	29.47 ± 2.91 29.0 (23.0–36.0)	31.13 ± 3.70 32.0 (23.0–45.0)	<0.001[&]
INR	0.93 ± 0.55 0.89 (0.76–8.86)	0.90 ± 0.05 0.89 (0.80–1.0)	0.91 ± 0.07 0.91 (0.68–1.23)	0.008[&]
SGPT (u/L)	29.52 ± 9.33 34.0 (18.0–43.0)	26.82 ± 8.52 27.0 (11.60–42.0)	32.04 ± 6.69 34.0 (11.0–41.0)	<0.001[&]
Glucose (mg/dL)	90.67 ± 8.01 90.0 (70.0–125.0)	90.15 ± 10.66 90.0 (70.0–137.0)	91.81 ± 9.97 90.0 (75.0–125.0)	0.173[&]
Creatinine (mg/dL)	0.75 ± 0.08 0.75 (0.56–1.0)	0.78 ± 0.12 0.77 (0.55–1.30)	0.76 ± 0.13 0.76 (0.45–1.20)	0.105[&]
TSH (mIU/L)	4.03 ± 0.78 4.0 (2.45–6.40)	2.91 ± 1.39 2.66 (0.35–6.45)	3.28 ± 1.74 2.98 (0.29–23.60)	<0.001[&]
Diameters (mm)	33.51 ± 4.01 34.0 (19.0–43.0)	–	60.51 ± 14.55 60.0 (35.0–100.0)	<0.001[#]

[&], Kruskal-Wallis Test; [#], Mann-Whitney U test; SD, standard deviation; E2, estrogen; Pg, progesterone; HTC, hematocrit; HGB, hemoglobin; WBC, white blood cell count; PLT, platelet; APTT, activated partial thromboplastin time; INR, international normalized ratio; SGPT, serum glutamate pyruvate transaminase; TSH, thyroid stimulating hormone.

(Group III). The average age of patients who underwent myomectomy and abdominal wall endometrioma was 43.0 (31.0–58.0) years, and 31.0 (20.0–43.0) years respectively. A control group was created, including a similar number of patients who gave birth by cesarean section in the same period and did not develop abdominal wall endometrioma (Group II). We followed patients for approximately 1.5–2 years to determine the development of endometrioma after cesarean section and myomectomy surgeries. Preoperative laboratory values were compared and are shown in Table 1. In this table, we compared various laboratory parameters between the 3 different patient groups. There was a significant difference in age between the groups ($p < 0.001$). Group III was on average older [43.0 (31.0–58.0) years] while Group I had a lower average age [31.0 (20.0–43.0) years]. There was a significant difference in estrogen (E2) levels ($p < 0.001$). Group I had the highest average E2 level [188.0 (37.0–396.0) years]. There was also a significant difference in progesterone (Pg) levels ($p < 0.001$). Group III had the highest average Pg level [3.0 (0.10–32.0) ng/mL]. There were significant differences in hematocrit (HTC) and hemoglobin (HGB) values between all 3 groups ($p < 0.001$). There was a significant difference in platelet (PLT) counts ($p < 0.001$). It was noted that Group I had the highest mean PLT count. The activated partial thromboplastin time (APTT) of the myomectomy group was longer than the other groups ($p < 0.001$). There was a significant difference in the international normalized ratio (INR) levels ($p = 0.008$). There was a significant difference in serum glutamate pyruvate transaminase (SGPT) level ($p < 0.001$).

Table 2. Dunn's multiple comparisons test.

Groups	Age	Estrogen	Pg	HTC	HGB	PLT	APTT	INR	SGPT	TSH
Myomectomy/Caserean with endometrıoma (Group III/Group I)	<0.001	0.072	<0.001	0.002	<0.001	<0.001	<0.001	0.950	0.006	<0.001
Myomectomy/Caserean (Group III/Group II)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.026	<0.001	0.052
Caserean with endometrıoma/Caserean (Group I/Group II)	<0.001	<0.001	0.463	0.771	0.423	<0.001	0.973	0.714	0.007	<0.001

There was no significant difference between the groups in glucose levels ($p = 0.173$). There was no significant difference in creatinine levels ($p = 0.105$). It was noted that Group II had the highest median 0.77 (0.55–1.30) mg/dL. There were significant differences in thyroid stimulating hormone (TSH) values ($p < 0.001$). TSH value was higher in Group I [4.0 (2.45–6.40) mIU/L]. There was also a significant difference in diameters levels between Group I and Group III ($p < 0.001$). The myomectomy group stands out with the largest average diameter and this parameter was not provided for group II.

The results of Dunn's multiple comparisons Test are presented in Table 2. According to these results, the differences in ages between all comparison groups were statistically significant ($p < 0.001$). There was no significant difference in E2 levels between Group III and Group I ($p = 0.072$). There was a statistically significant difference in E2 levels between Group III and Group II ($p < 0.001$). There was a statistically significant difference in E2 levels between Group I and Group II ($p < 0.001$). Regarding Pg values, the differences between Group III and Group I, as well as between Group III and Group II, were statistically significant ($p < 0.001$). However, the difference between Group I and Group II was not statistically significant ($p = 0.463$). For HTC values, the difference between Group III and Group I was statistically significant ($p = 0.002$), as was the difference between Group III and Group II ($p < 0.001$). However, the difference in HTC values between Group I and Group II was not statistically significant ($p = 0.771$). Regarding HGB values, the differences between Group III and Group I, as well as between Group III and Group II, was statistically significant ($p < 0.001$). The difference between Group I and Group II was not statistically significant ($p = 0.423$).

The differences in PLT between all comparison groups were statistically significant ($p < 0.001$).

Regarding APTT values, the differences between Group III and Group I, as well as between Group III and Group II, were statistically significant ($p < 0.001$). However, the difference between Group I and Group II was not statistically significant ($p = 0.973$).

Regarding INR values, the difference between Group III and Group I was not statistically significant ($p = 0.950$). The difference between Group III and Group II was statistically significant ($p = 0.026$). The difference between Group I and Group II was not statistically significant ($p = 0.714$). For SGPT values, the difference between Group III and Group I was statistically significant ($p = 0.006$). The difference between Group III and Group II was statistically significant ($p < 0.001$). The difference between Group I and Group II was statistically significant ($p = 0.007$). Regarding TSH values, the difference between Group III and Group I was statistically significant ($p < 0.001$). The difference between Group III and Group II was not statistically significant ($p = 0.052$). The difference between Group I and Group II was statistically significant ($p < 0.001$).

Myoma patients presented to the gynecology clinic due to complaints of prolonged menstrual bleeding and dysmenorrhea. During the transvaginal ultrasound (TVUS) examination, an intramural myoma was detected in 105 patients, submucous myoma in 35 patients, and intramural and submucous myoma detected in 60 patients (Figs. 1,2). Ovarian endometriosis was present in 105 of these patients. These patients were operated on by gynecologists. Pathology results were compatible with leiomyoma uteri (Fig. 3). The hospital stay was for 2 days. In the postoperative period, surgical site infection developed in 6 patients and hematoma at the incision line in 3 patients. Hematoma drainage was performed in only 1 patient. Surgical site infection resolved with antibiotic treatment. During the follow-up period, abdominal wall endometrioma developed only in the patient who underwent intervention due to myomectomy + ectopic pregnancy at the same time (0.5%). Characteristics of the 3 groups are shown in Tables 3,4.

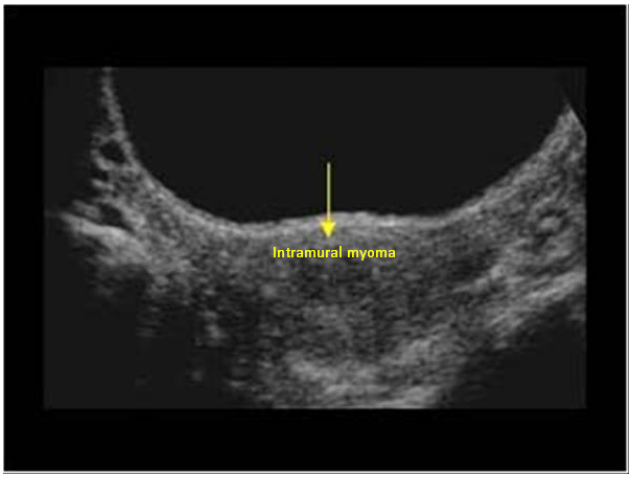

Fig. 1. Transvaginal ultrasonography of intramural myoma.

Table 3. Characteristics of patients.

	Group I (n = 204)	Group II (n = 204)	Group III (n = 200)	*p*
Pain				
Yes (cyclic/non-cyclic)	202 (182/20) (99.0%)	0 (0.0%)	174 (87.0%)	<0.001[&]
No	2 (1.0%)	204 (100.0%)	26 (13.0%)	
Bleeding				
Yes	0 (0.0%)	0 (0.0%)	120 (60.0%)	<0.001[&]
No	204 (100.0%)	204 (100.0%)	80 (40.0%)	
Mass in the abdominal/uterine wall				
Abdominal wall	204 (100.0%)	0 (0.0%)	1 (0.5%)	<0.001[&]
Uterine wall	0 (0.0%)	0 (0.0%)	199 (99.5%)	
Frequent urination				
Yes	0 (0.0%)	0 (0.0%)	16 (8.0%)	<0.001[&]
No	204 (100.0%)	204 (100.0%)	184 (92.0%)	
Radiologic examination (Ultrasound-US)				
Superficial US	204 (100.0%)	0 (0.0%)	0 (0.0%)	
Superficial implant	110 (53.9%)	0 (0.0%)	0 (0.0%)	
Intermediate implant	94 (46.1%)	0 (0.0%)	0 (0.0%)	
Transvaginal US	0 (0.0%)	0 (0.0%)	200 (100.0%)	<0.001[&]
Intramural	0 (0.0%)	0 (0.0%)	105 (52.5%)	
Submucous	0 (0.0%)	0 (0.0%)	35 (17.5%)	
Intramural + submucous	0 (0.0%)	0 (0.0%)	60 (30.0%)	
Intraabdominal endometriosis				
Yes	11 (5.4%)	16 (7.8%)	28 (14.0%)	0.008[&]
No	193 (94.6%)	188 (92.2%)	172 (86.0%)	
Location				
Posterior	0 (0.0%)	0 (0.0%)	168 (84.0%)	
Other	0 (0.0%)	0 (0.0%)	32 (16.0%)	<0.001[&]
Right	160 (78.4%)	0 (0.0%)	0 (0.0%)	
Left	44 (21.6%)	0 (0.0%)	0 (0.0%)	
Pathology				
Leiomyoma uteri	0 (0.0%)	0 (0.0%)	199 (99.5%)	
Endometriosis	203 (99.5%)	0 (0.0%)	1 (0.5%)	<0.001[#]
Others (desmoid tumor)	1 (0.5%)	0 (0.0%)	0 (0.0%)	
Complication				
Yes	1 (0.5%)	6 (2.9%)	9 (4.5%)	0.040[&]
No	203 (99.5%)	198 (97.1%)	191 (95.5%)	
Recurrence				
Yes	9 (4.4%)	0 (0.0%)	0 (0.0%)	<0.001[#]
No	195 (95.6%)	204 (100.0%)	200 (100.0%)	

[&], Pearson Chi-Square test; [#], Fisher-Freeman-Halton Exact Test.

Abdominal wall endometrioma was detected in the physical and radiological examination (superficial ultrasound) (Fig. 4) of 204 patients who presented to our general surgery clinic due to complaints of swelling and pain in the abdominal wall. Masses were on the right side of the incision line in 160 (78.4%) patients. In the superficial ultrasound of the patients, AWE was above the rectus fascia in 110 patients and at the level of the rectus abdominis fascia in 94 patients. In only 1 patient, the mass was localized outside the cesarean scar site. Wide excision was performed under general anesthesia in 204 patients. The pathology of 203 patients was evaluated as compatible with endometrioma (Fig. 5). The pathology result of the remaining 1 patient was compatible with desmoid tumor. Postoperatively, only 1 patient had a hematoma. She recovered with conservative treatment. Repeat pregnancy was planned in 204 patients after an average of 2.5 years. AWE recurred in 9 of the patients in Group I during the follow-up period (4.4%). These patients underwent repeat total excision.

Abdominal wall endometrioma did not develop during the follow-up period in our 204 patients (Group II) who gave birth via cesarean section, although 16 of them had ovarian and peritoneal endometriosis. No pathological findings were found in the subsequent follow-up of our patients in this group, who had an average of 3 births.

Table 3: while 174 (87.0%) of the patients in Group III had pain in the preoperative period, this rate was 202 (99.0%) in patients who developed endometrioma after ce-

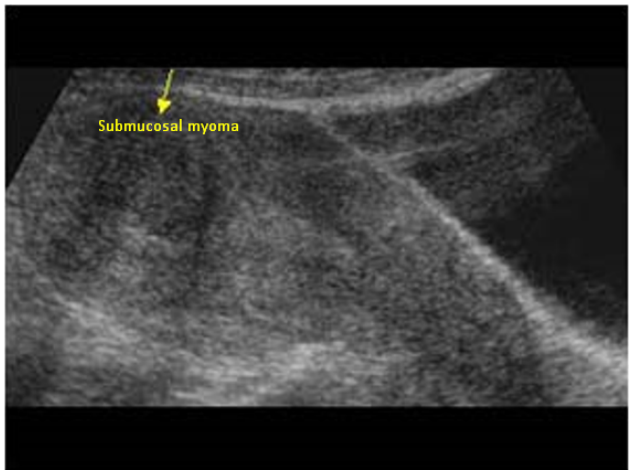

Fig. 2. Transvaginal ultrasonography of submucous myoma.

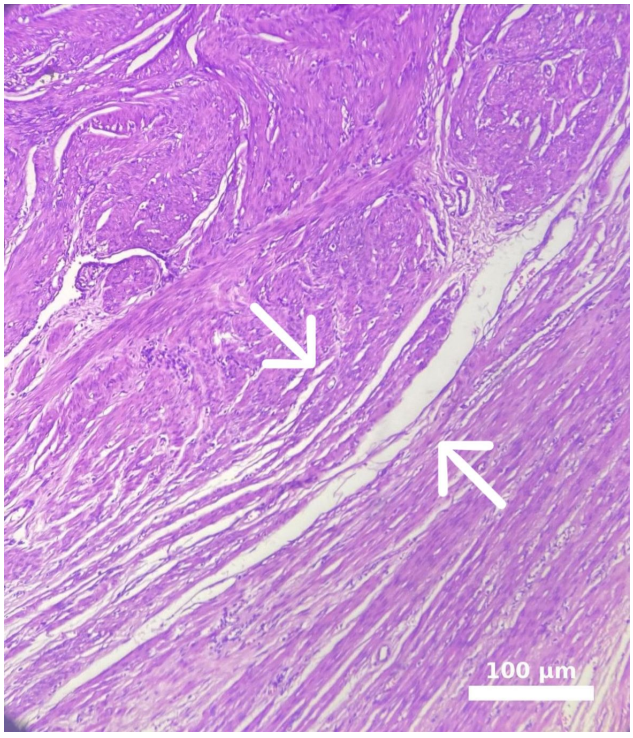

Fig. 3. Microscopic appearance of intramural myoma. The white line marked with a white arrow in the image delineates the border between the leiomyoma and the adjacent myometrium. Endometrioma tissue is visible on the left side. The myometrium in the lower right corner appears distorted due to pressure, while an intramural myoma is observed in the upper left corner. Scale bar: 100 µm (H&E, hematoxylin and eosin, ×10).

sarean section ($p < 0.001$). There was no reported pain in cesarean section patients who did not develop endometrioma. In Table 3, 120 (60.0%) patients undergoing myomectomy reported bleeding, but there was no bleeding in any of the other 2 procedures ($p < 0.001$). A mass on the abdominal wall was detected in cases who developed endometri-

Table 4. Prior surgeries.

	Group I (n = 204)	Group II (n = 204)	Group III (n = 200)
YES			
Appendectomy	11 (5.39%)	10 (4.90%)	7 (3.50%)
Caserean	29 (14.21%)	35 (17.1%)	6 (3.0%)
Cholecystectomy	4 (1.96%)	3 (1.47%)	2 (1.0%)
Cystocele	3 (1.47%)	1 (0.49%)	2 (1.0%)
Rectocele	0 (0.0%)	1 (0.49%)	3 (1.5%)
Hemorrhoidectomy	7 (3.43%)	9 (4.41%)	3 (1.5%)
Thyroidectomy	2 (0.98%)	2 (0.98%)	3 (1.5%)
Inguinal hernia	0 (0.0%)	0 (0.0%)	5 (2.5%)
Ovarian abscess	0 (0.0%)	0 (0.0%)	1 (0.5%)
Ovarian cyst rupture	0 (0.0%)	1 (0.49%)	1 (0.5%)
Peptic ulcus perforation	0 (0.0%)	0 (0.0%)	1 (0.5%)
NO	148 (72.5%)	142 (69.6%)	166 (83.0%)

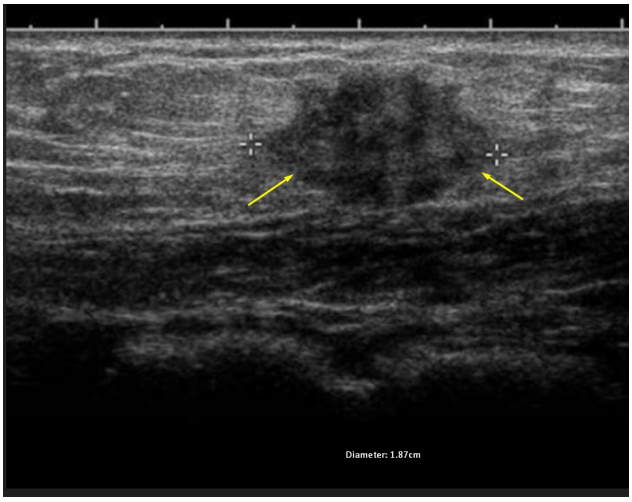

Fig. 4. Superficial ultrasonography of abdominal wall endometrioma.

oma after cesarean section and in 1 patient in Group III. Frequent urination was a complaint seen only in patients with myoma. Frequent urination was observed in 16 (8.0%) of patients in Group III, while this problem was not reported in the other 2 groups ($p < 0.001$) in Table 3. Transvaginal ultrasound was used as a radiological diagnosis method in patients with myoma and abdominal ultrasound was used in patients with endometrioma. Intra-abdominal endometriosis was seen in 28 (14.0%) patients with myoma, 11 (5.4%) in cesarean section patients with endometrioma, and 16 (7.8%) in normal cesarean section patients (Table 3). Although there was more intra-abdominal endometriosis in myomectomy patients, more endometriomas were detected in Group I ($p < 0.001$). In the cesarean section patients with endometrioma, 160 (78.43%) endometriomas were found to be localized to the right of the cesarean section incision and 44 (21.56%) to the left. Myomas were found to be located

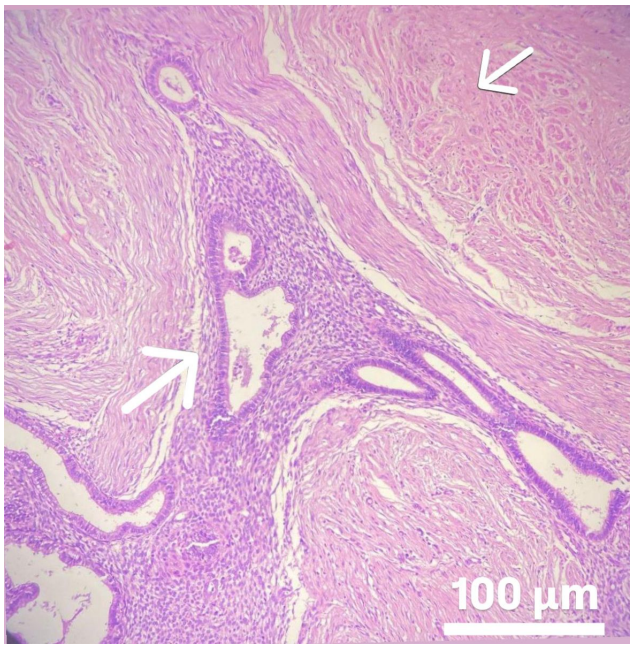

Fig. 5. Microscopic appearance of abdominal wall endometrioma. Arrows indicate ectopic endometrial tissue with preserved gland and stroma integrity within striated muscle and connective tissue. The rectus muscle is located in the upper right corner, while the abdominal wall endometrioma is visible in the lower left corner. Scale bar: 100 µm (H&E, hemtoxylin and eosin, ×10).

in the posterior part of the uterus in 168 (84.0%) patients and in other regions in 32 (16.0%) patients. Endometriosis pathology was detected in 203 (99.5%) patients in Group I and only 1 (0.5%) patient in Group III ($p < 0.001$). Complications such as wound infection and hematoma were reported at a rate of 9 (4.5%) in myomectomy patients, 1 (0.5%) in cesarean section cases with endometrioma, and 6 (2.9%) in normal cesarean section cases ($p = 0.040$). A recurrence rate of 9 (4.4%) was detected only in Group I after the operation ($p < 0.001$).

Table 4 shows the past surgical operations of the patients for the 3 groups. No previous surgical interventions related to endometriosis were detected in any of the groups.

4. Discussion

Endometriosis is a gynecological disease marked by the presence of endometrial tissue outside the uterus. This growth can be categorized based on location as either pelvic, involving the uterosacral ligaments, ovaries, fallopian tubes, and pouch of Douglas, or extra pelvic, affecting areas such as surgical scars, groin, diaphragm, kidneys, liver, lungs, and pleura [10,11]. Sometimes endometrial tissue starts to grow on the skin [12]. There are 2 main types of cutaneous endometriosis: Primary (spontaneous) cutaneous endometriosis occurs when endometrial tissue implants into the skin without any prior surgery or trauma in that area. Its etiology is not clear [13]. Secondary (scar) cutaneous endometriosis occurs when endometrial tissue is inadvertently implanted into the skin during a surgical procedure, such as a cesarean section or episiotomy [12,13]. The most common symptoms of both types are cyclic pain, swelling, and the formation of nodules or lumps in the skin. Scar endometriosis occurs most commonly after cesarean section, at the corners of the Pfannenstiel incision line [14]. In their study, Ping Zhang *et al*. [14] found Pfannenstiel incision in 80% of their patients presenting with cesarean scar endometriosis. In our study, scar endometriosis was in the Pfannenstiel incision line in 203 patients. It was localized outside the incision line in only 1 patient. The mean age of affected women varied from 20–43 years with an average of 31.0 years [4].

The prevalence of endometriosis worldwide is estimated to be between 10% and 15% [15]. Structural differences of endometrioma cells arise from abnormalities in their location.

If endometrial cells settle outside the uterus, there is the potential for them to lose their normal functions. These cells normally grow and shed in a cyclical manner within the uterus. However, if they are located outside the uterus, this cyclical change may be disrupted and lead to abnormal tissue growth. Factors affecting the development of endometriosis include conditions such as genetic predisposition, immune system disorders, hormonal imbalances (especially estrogen hormone), inflammation and infections developing in the incision line [16]. Patients with endometriosis may have alterations in iron metabolism (serum iron level, ferritin, transferrin saturation, total iron binding capacity) due to chronic inflammation and menstrual blood loss [17]. Monitoring these markers of iron metabolism can help healthcare providers assess iron status and make appropriate recommendations for supplementation or treatment in patients with endometriosis. These factors lead to the formation of a pro-inflammatory environment that supports the continued presence of endometriosis, which is closely associated with the two primary symptoms of the disease: pain and infertility. So far, no specific marker for endometriosis has been detected in peripheral blood or endometrium [18]. The markers used were analyzed together with the patient's clinical and radiological findings. Intra-abdominal endometriosis was present in 5.4% of our patients who developed scar endometriosis (Group I), 7.8% of our patients who did not develop scar endometriosis (Group II), and 14% of our patients who underwent surgery for myoma (Group III). There was no significant difference in the peripheral blood picture of all 3 groups. Rather than specific markers, the clinical and radiological findings of the patients were more significant during diagnosis.

The development of endometrioma in the abdominal wall can often be under the influence of estrogen as in our study. Group I has the highest average estrogen level 188.0 (37.0–396.0) pg/mL ($p < 0.001$) as shown in Table 1. Also, it is known that platelets play an important role in the devel-

opment of endometriosis. Some substances released from these cells prepare the environment for the development of endometriosis. In our study, PLT levels were found to be significantly higher in our Group I patients, as seen in Table 1. As a result of these factors coming together, it is possible for endometrial cells to proliferate outside the uterus and form an endometrioma.

Due to the recent increase in cesarean deliveries, it has been determined that there is an increase in the prevalence of abdominal wall endometriomas. It has been shown that the indication for cesarean section and surgical technique are not factors contributing to the development of endometriomas, as they are not seen after every cesarean section, although the risk of implantation is equal [4]. Our study also supports this situation. Only 204 of our 19,574 cesarean section patients developed scar endometriosis. Therefore, other factors such as genetics, endocrine factors, or wound environment may be contributory. Therefore, the factors determining the spread of endometrial cells and the formation of an endometrioma may differ among patients.

The incidence of abdominal wall endometrioma after cesarean section is very rare (0.03–1%) [19]. In our study it was 1.04%. Surgical technique, handling of tissue, the method of closing incisions, as well as the materials and sutures used, might affect implantation risk. Patient demographics: some populations may have genetic predispositions that increase the likelihood of endometriosis, including abdominal wall endometriomas, due to differences in hormonal receptor sensitivity or immune responses [20]. Variability in menstrual cycle characteristics, such as shorter cycles or heavier flows, could contribute to increased incidences due to more aggressive endometrial growth and potential seeding during surgical interventions [20]. Abdominal wall endometriomas and intra-abdominal endometriomas are not usually seen together. However, in rare cases, both types of endometriomas can be found in the same person. The probability of this situation occurring is very low. In our study, 11 patients in Group I had scar endometriosis and intra-abdominal endometriosis at the same time (5.4%).

However, there is no clear explanation as to exactly why endometrioma occurs, and it is thought that it may be under the influence of many factors. In a study by Ozel *et al*. [19], it was recommended that specific cesarean delivery practices, including effective bleeding control, thorough washing of the abdominal cavity prior to closure, and minimizing subcutaneous dead space by carefully bringing together wound edges, could potentially diminish the occurrence of AWE. The average duration between the initial surgery and the onset of AWE symptoms was found to be 14.1 months (range 1 to 72 months). In our study, AWE developed on average within 12–18 months after cesarean section.

Abdominal wall endometriosis typically presents with a noticeable lump under the skin near a previous surgical scar, accompanied by increased pain and swelling during menstruation. This condition is commonly characterized by menstrual pain, especially in individuals who have undergone cesarean section. If a palpable mass is found in the area of a surgical scar in conjunction with a history of cesarean section and menstrual pain, the diagnosis of abdominal wall endometriosis should be strongly considered [8]. Ping Zhang and colleagues [14] found that the most common reason for admission of their patients was an abdominal mass (98.5%) and accompanying cyclic pain in 87%. In our study, pain was cyclic in 182 of our patients (89.2%). Twenty of our patients described pain only with touch. Two patients with a scar endometriosis diameter of $\leq$2 cm did not describe pain. Pain was more pronounced in our patients with a larger scar endometriosis diameter.

Ultrasonography is the first-line diagnostic imaging method in the evaluation of abdominal wall abnormalities [21]. Three positions for abdominal wall endometrioma (AWE) have been identified based on its location relative to the rectus abdominis muscle: superficial placement (above the fascia of the rectus muscle), intermediate placement (at the level of the fascia of the rectus muscle), and deep placement (below the fascia of the rectus muscle) [22]. In our study, AWE localized under the muscle was not detected. On ultrasound, AWE appears as a heterogeneous hypoechoic mass with hemorrhagic and fibrous components present.

Fine needle aspiration (FNA) cytology was deemed unnecessary due to clear clinical and radiological imaging findings, along with the history of previous cesarean section, making the diagnosis of abdominal wall endometriosis well-documented. Confirmation of the diagnosis was achieved through histopathological examination of the surgical specimen. In 203 of our patients, the pathology result was consistent with endometriosis. Desmoid tumor was detected in only 1 patient. The standard treatment method is wide surgical excision [23]. Pharmacological treatment is palliative, and not effective in treating the disease completely.

Ping Zhang *et al*. [14], Rohit Nepali *et al*. [24], and Fatimah Alnafisah *et al*. [25], similarly managed their cases by performing surgical excision of the mass. The reported risk of recurrence following surgery ranges from 5–9% [23]. Consequently, during the excision of the mass, it is essential to ensure at least 1 cm of surrounding tissue is removed to reduce the likelihood of recurrence [26]. Recurrence was detected in 9 of our 204 patients with AWE after the next caesarean section (4.41%). We re-operated on these patients with clean surgical margins. In our patients, the AWE diameter was between 1.87 and 4.3 cm. During operation, mesh placement was not deemed necessary to repair the fascial defect. We did not have any patients who developed a hernia.

The malignancy risk of endometriosis in any region is 1%. Malignant transformations of atypical well-differentiated endometriosis are indeed rare, with clear cell carcinoma and adenocarcinomas being documented in the literature [27,28]. No cases of cancer were identified in our study. In cases where malignancy does occur, around 80% of them are associated with endometriosis in the ovary, while the remaining 20% are found in extra-gonadal sites, such as the abdominal wall [28].

Another reason for intervention in the uterine wall is the benign masses of the uterine wall called adenomyosis. Adenomyosis is the cause of 20–30% of hysterectomy surgery. Adenomyosis can arise directly from the extension of the basal layer of the endometrium into the myometrium. Adenomyosis occurs when the endometrial glands extend into the myometrium, resulting in an ectopic location due to disruptions in the tissue barrier between the endometrial basal layer and the myometrium [29].

Ectopic localization can manifest as diffuse (adenomyosis) or focal (adenomyoma), impacting various areas of the uterus, with the posterior uterine wall frequently affected [29]. This occurrence may follow surgical curettage or placental invasion, potentially leading to additional disruptions and invasion of the endometrium. It is recognized as a type of endometriosis variant, with both conditions co-occurring in around 20% of individuals affected [16]. The most common symptoms of the disease are uterine tenderness and enlargement, dysmenorrhea, menorrhagia and dyspareunia. In 168 of our 200 patients who underwent myomectomy, the myoma was localized on the posterior wall. The incidence of the disease is higher in multiparous women as in our study [16].

In recent years, magnetic resonance imaging (MRI) and ultrasound have emerged as the preferred imaging techniques for diagnosing adenomyosis. Transvaginal ultrasonography (TVUS) is particularly favored in gynecological examinations because it enables a dynamic assessment of organ mobility and position. Through both two-dimensional (2D) and two-dimensional (3D) configurations, as well as color flow Doppler technology, TVUS provides a detailed view of the uterus and any associated pathologies [16]. Additionally, it is more accessible and cost-effective compared to MRI.

In transvaginal ultrasound (TVUS), adenomyosis may present as heterogeneous myometrium, cysts within the myometrium, linear patterns within the myometrium, areas with indistinct borders, unclear connection between the endometrium and myometrium, and thickening of the myometrium [30,31]. Various studies have reported sensitivity and specificity values for TVUS in diagnosing adenomyosis ranging from 87.1% to 57.4% and 97.5% to 60.1%, respectively [16].

Adenomyosis can be treated with uterus-sparing excisional techniques, which include complete excision of adenomyosis, known as adenomyomectomy, for cases of focal adenomyosis (adenomyoma), and partial excision or cytoreductive surgery for more extensive cases, referred to as diffuse adenomyosis.

During surgery of adenomyotic lesions, they should be carefully separated from the normal myometrium tissue to avoid damaging the normal myometrial tissues. There was no widespread adenomyosis in our patients. Therefore, only total excision of myomas was performed through transverse Pfannenstiel incision.

5. Conclusions

Endometriosis is a complex and often debilitating condition that affects a significant number of individuals worldwide, causing pain, infertility, and various quality-of-life issues. Despite significant research efforts, there remain significant gaps in our understanding of its etiology, progression, and treatment outcomes. Although patients in Groups I and II (control group) underwent caesarean section, abdominal wall endometrioma developed in all patients in Group I, but it was not detected in Group II. In Group III, where myomectomy was performed, abdominal wall endometriomas developed only in a patient with an ectopic pregnancy.

It should be considered that conditions such as endometriosis and endometrioma are multifactorial and that iatrogenic factors may play a role. During menstruation, endometrial cells migrate backwards from the fallopian tubes and leak into the pelvic cavity where they implant. Genetic factors, especially the growth of these tissues secondary to excessive production of hormones such as estrogen, immune system disorders allowing endometrial tissue to survive and grow outside the uterus, and incorrect surgical techniques are important to understand the cause and effect relationship. In our patients' hematological tests, some valuessuch as E2 and PLT count are high, as well as an increase in insulin-like growth factor 1 (IGF-1) and a decrease in Caspase 3, supporting endometrioma formation. We are continuing our prospective study to determine the effect of IGF-1 on endometrioma formation.

More detailed prospective studies are needed to understand the pathophysiology of the disease and to identify risk factors. Prospective studies are vital to assessing the long-term effectiveness and safety of current and new treatments. These studies can help determine which treatments work best for specific patient groups, leading to more personalized and effective care. The main limitation of our study was that it was retrospective in nature and our resources were limited.

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

NS: conception, formal analysis, investigation, methodology, writing original draft in English, re-writing after review and final edition, operations on patients, and obtaining Ethics Committee approval. SA: operations on patients, data curation, interpretation of data and review. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final version of manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was carried out in accordance with the guidelines of the Declaration of Helsinki. Approval of the present study was obtained from the institutional review board of University of Medipol, Medical Faculty (29.11.2023/E-10840098-772.02-7514). As some of the patients were illiterate, we obtained written consent from their relatives with the permission of the Ethics Review Board. Thus, all subjects gave their informed consent for inclusion before they participated in the study.

Acknowledgment

We would like to express our gratitude to the referees for their suggestions and contributions. We would also like to thank Prof. Dr. Ozkan GORGULU, Head of the Department of Biostatistics at Kırsehir Ahi Evran University, who made the statistical calculations in this study.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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