Tubal Endometriosis

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Tubal endometriosis (EM) refers to the detection of ectopic endometrial implants on tubes. It may cause a significant defect of the tubes, translating into dysmenorrhea, pelvic pain, and infertility.

tubal endometriosis | fallopian tube | endometriosis

1. Introduction

Endometriosis (EM) is a chronic benign gynecological disease, which is defined as the presence of endometrial deposits outside the uterine cavity [1]. The estimated prevalence of the disease is approximately 10% among women of reproductive age [2]. Endometriosis is most commonly identified in the pelvis and it affects the ovaries, the pelvic peritoneum cul-de-sac and uterosacral ligaments [3]. Additionally, less common extrapelvic endometriosis sites in the gastrointestinal and urinary tract, chest and brain have also been recorded, while there are also reports of multiple endometriosis sites especially in patients with deep infiltrating (DIE) endometriosis in as high as 44% of them [3][4]. Pain and infertility are the most common primary symptoms encountered in 30–50% of women with EM [5]. Retrograde menstruation, firstly described by Sampson et al., has been considered as the most prevalent theory for the pathogenesis of EM [2]. Women with obstructive outflow diseases are considered more susceptible to retrograde menstrual flow, which could facilitate the transportation of endometriotic menstrual cells to the peritoneal cavity through the fallopian tubes [2]. The genetic and epigenetic theory, according to which already existing endometrial cells are modified and result in the development of the clinical manifestation of the disease, could explain why not all women with retrograde menstruation will develop EM [6]. Coelomic metaplasia is another theory that supports the transformation of peritoneal, pleural and ovarian mesothelial cells to endometriosis, while theories about the lymphatic and vascular spread of endometrial cells are still under investigation [7]. Treatment options may range from conservative medication hormonal-based treatment to more invasive surgical procedures. Despite the benign nature of the disease, the risk of malignant transformation reaches a proportion of approximately 1% [8]. History of EM is related to a significantly elevated risk of developing ovarian cancer [8]. The most common histological subtypes arising from EM are endometrioid adenocarcinoma, clear cell carcinoma and low-grade serous carcinoma [8][9]. Histopathologically, the malignant transformation is recognized as cytologic atypia and architectural proliferation [10]. Cytologic atypia is defined as the transition from benign EM to carcinoma and is classified as moderate (simple hyperplasia or cellular atypia) or severe (complex hyperplasia or cellular atypia that is more evident) [11]. Concerning cellular proliferation, complex hyperplasia is translated into glandular proliferation and reduced stroma, which can evolve towards ovarian cancer [11]. As mentioned above, endometrioid carcinoma or clear cell carcinoma are the most prevalent types, and their gross appearance consists of the typical histology of each type of malignancy including cribiform, glandular or solid architecture and papillary, solid or tubulocystic

architecture for each cancer type, respectively [11]. Mitoses are also detected in both types. Endometriosis associated ovarian cancer (EAOC) is defined as the coexistence of malignant cells and EM either in the same ovary or EM in the one and cancer in the other ovary [10][11].

Tubal EM is defined as the detection of ectopic endometrial implants on the tubes. It may cause a significant defect of the fallopian tubes and functional and structural disorders, which may translate into dysmenorrhea, pelvic pain and infertility. Notwithstanding the multiple reports on the potential contribution of tubal EM on the pathogenesis of endometriosis related symptomatology, the exact aspects of the disease still remain elusive.

2. Excluded Studies

A total of 3 studies were excluded from tabulation and analysis after reading their full text. More specifically, the study by Chakrabarti et al. was excluded as reported a case of EM that was developed in the fallopian stump four years after salpingectomy [12]. The studies by Sinha et al. and Audebert et al. did not present separate outcomes of patients with tubal EM apart from the prevalence of the disease among their study populations and were thus excluded [13][14].

3. Included Studies

A total of 13 studies were finally considered eligible for inclusion [15][16][17][18][19][20][21][22][23][24][25][26][27]. Among them, four were observational, which included a total of 633 patients and mainly focused on the prevalence of tubal EM among patients with various gynecological diseases, as well as on disease-related characteristics and histopathology [15][16][17][18], while two studies focused on analyzing the genetic profile of patients with tubal EM [19][20]. The remaining seven studies were case reports [21][22][23][24][25][26][27]. The main patient and disease characteristics of the included observational studies are shown in **Table 1**. A summary of the findings of the case reports is also depicted in **Table 2**.

Table 1. Characteristics of the included observational studies and patients.

Year; Author	***2018; Xia***	***2019; Qi***	***2020; Xue***	***2020; Mcguinness***
Country	China	China	China	USA
Type of study	PS	Cross-sectional	RS	RS
Study period	06/2016–08/2017	06/2016–08/2017	01/2002–07/2019	07/2015–06/2018
Inclusion criteria	Patients with uterine leiomyoma and adenomyosis treated with hysterectomy and salpingectomy; no hormonal medication within 3	Premenopausal; unilateral or bilateral salpingectomy; complete data; no pregnancy; consent for participation	Salpingectomy	Surgery for EM by MIS; age < 55; no malignant cases; no previous laparotomy; no previous bil salpingectomy

Year; Author	2018; Xia	2019; Qi	2020; Xue	2020; Mcguinness
	mo; no history of tubal surgery			
Main outcomes	Ciliary beat frequency (CBF)	Characteristics, prevalence, clinical features, pathologic features, predictors of EM	Prevalence of tubal EM among groups	Prevalence of tubal EM among groups
Compared groups	AM without EM vs. EM without AM vs. control (uterine leiomyoma)	EM vs. no EM	EM vs. BN vs. MT	Salpingectomy vs. no salpingectomy
Indication for surgery	Leiomyoma, AM, EM	Fibroid, ovarian cyst, salpingitis/infertility, hydrosalpinx, malignancy, tubal sterilization, adenomyosis, EM	Leiomyoma, adenomyosis, endometrioid cysts, hydrosalpinx, uterine malformation, malignancy	EM, pelvic pain, cystic adnexal mass, infertility, fibroids, AUB
Patients (n)	75 (20 vs. 35 vs. 20)	1112 (161 vs. 951)	261 (178 vs. 65 vs. 18)	185 (97 vs. 88)
Patients age (years)	44.4 ± 5.2 [a] vs. 43.4 ± 5.1 [a] vs. 47.2 ± 4.8 [a] (AM vs. EM vs. control)	44.89 ± 6 [a] vs. 45.9 ± 5.97 [a], $p = 0.002$ (tubal EM vs. no EM)	44 ± 7 [a] (total)	41.26 ± 7.45 [a] vs. 34.24 ± 7.37 [a] (salpingectomy vs. no salpingectomy)
Other EM sites	N/A	Ovarian EM L: 70/R: 53/Bil: 34	Ovarian EM L: 70/R: 49	N/A
Site of EM (L/R/Bil)	N/A	84 (40.37%)/65 (52.17%)/12 (7.45%), $p < 0.005$ (for L/R)	168 (55.08%)/93 (30.49%)/44 (14.43%), $p < 0.001$ (for L/R)	N/A
Prevalence of tubal EM	24/35 (69%) for EM group	161/1112 (14.48%)	EM group: 178 (68.2%) BN group: 65 (24.9%) MT group: 18 (6.9%)	34/97 (35%) salpingectomy group vs. 8/88 (9%) no salpingectomy group
Location in tube (tubal site/histologic layer)	N/A	Proximal: 78 (48.45%) Distal: 78 (48.45%) Proximal + distal: 5 (3.1%)/	N/A	N/A

Year; Author	2018; Xia	2019; Qi	2020; Xue	2020; Mcguinness
		Mucosa: 88 (54.66%) Myosalpinx: 10 (6.21%) Serosa: 52 (32.3%) Mucosa + serosa: 11 (6.83%)		
Predisposing factors	N/A	Previous EM, multi-organ EM, uterine seromuscular EM, severity of pelvic EM, young age, AUB, previous tubal ligation	N/A	N/A

RS: retrospective, EM: endometriosis, AM: adenomyosis, BN: benign disease, MT: malignant disease, MIS: minimally invasive surgery, AUB: abnormal uterine bleeding, PID: pelvic inflammatory disease, IUD: intrauterine device, L: left, R: right, Bil: bilateral, [a] Mean ± SD, N/A: not available.

Table 2. Main characteristics of patients from case reports.

Year; Author	Age (Years)	Primary Symptom	Parity	Imaging Findings	Pre-Surgical Diagnosis (Indication for Surgery)/Operative Procedure-Findings	Menopausal Status	History of EM/IO EM Findings	Histological Findings	Side/Site of Tubal EM
2013; Wenger	18	Acute pelvic pain, oligomenorrhea, persistent dysmenorrhea and dyspareunia	Nulli	TVUS: hypoechoic structure 13 × 10 in the rectovaginal septum, MRI: oval-shaped nodule 30 × 20 mm hypertense structure on T1, hemoglobin products in T2	DIE/DL-multiple red, black, and white scarred EM implants in uterosacral ligaments, R tubal cyst, fallopian tube torsion, R distal portion salpingectomy and adhesiolysis	Pre	No/EM implants identified during surgery	Tubal endometrioma with multiple sclerotic and calcified areas, stroma cells and hemosiderin-laden macrophages	R distal portion
2012; Lim	30	5 month dysmenorrhea and dull lower abdominal pain	Nulli (virgin)	Thick-walled, complex cystic structures 21 × 21 mm and 53 × 34	Pelvic EM/DL-bilateral torted tubes and cystic dilation at the distal portion salpingectomy and adhesiolysis	Pre	No/EM implant (spot) identified during surgery	Extensive hemorrhagic infarction secondary to torsion and hematosalpinx with	Bilateral distal portion

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				mm (R and L ovary)				endometrial glands detection	
2011; Kahyaoglu	33	18 years infertility and mild EM, pelvic pain and vaginal bleeding after embryo transfer	Nulli	TVUS: R tubal ectopic ring	Ectopic pregnancy/Emergent laparoscopy- bilateral salpingectomy	Pre	Yes (pelvic peritoneum)	Bilateral tubal ectopic pregnancy with endometriotic implants	Bilateral
2010; Ozturk	31	Secondary infertility	Primi	TVUS: R hydrosalpinx 37 × 12 mm	Hydrosalpix/DL-dilated R tubal uterine mimicking hydrosalpinx, R salpingectomy	Pre	No/No IO EM implants	Intraluminal tubal EM	R mucosa
2004; Datta	34	Primary infertility	Nulli	TVUS: Polycystic ovaries, HSG: normal	Unexplained infertility/DL -atypical endometriotic deposit on R tube mimicking ectopic pregnancy, ovarian drilling	Pre	No/EM uterosacral implants identified during surgery	Not performed	R
2003; Ohara	49	Anemia, acute abdominal pain	Nulli	US: R elongated sausage-shaped cystic mass 6.2 × 3.3 cmm, CA 125: 57.7 U/mL	Hematosalpinx/Emergent laparotomy-R elongated distended dark purple tube with occluded fimbrial end triple twisted, TAH-RSO	Pre	No/EM implants identified during surgery	Extensive hemorrhagic infarction secondary to torsion and endometrial glands in the haematosalpinx	R
2002; De la Torre	60	Abdominal distension and pelvic pain	N/A	US: Tumor with solid and cystic components 10 cm, CT: L para-aortic node 1 cm	Ovarian cancer/Exploratory laparotomy- TAH BSO PL PaL	Post	N/A	Transitional areas between the newly formed and endometriotic epithelium lined the cystic cavity of tubal wall- Clear cell fallopian tube carcinoma with tubal EM	L-proximal portion 1 cm from uterine ostium

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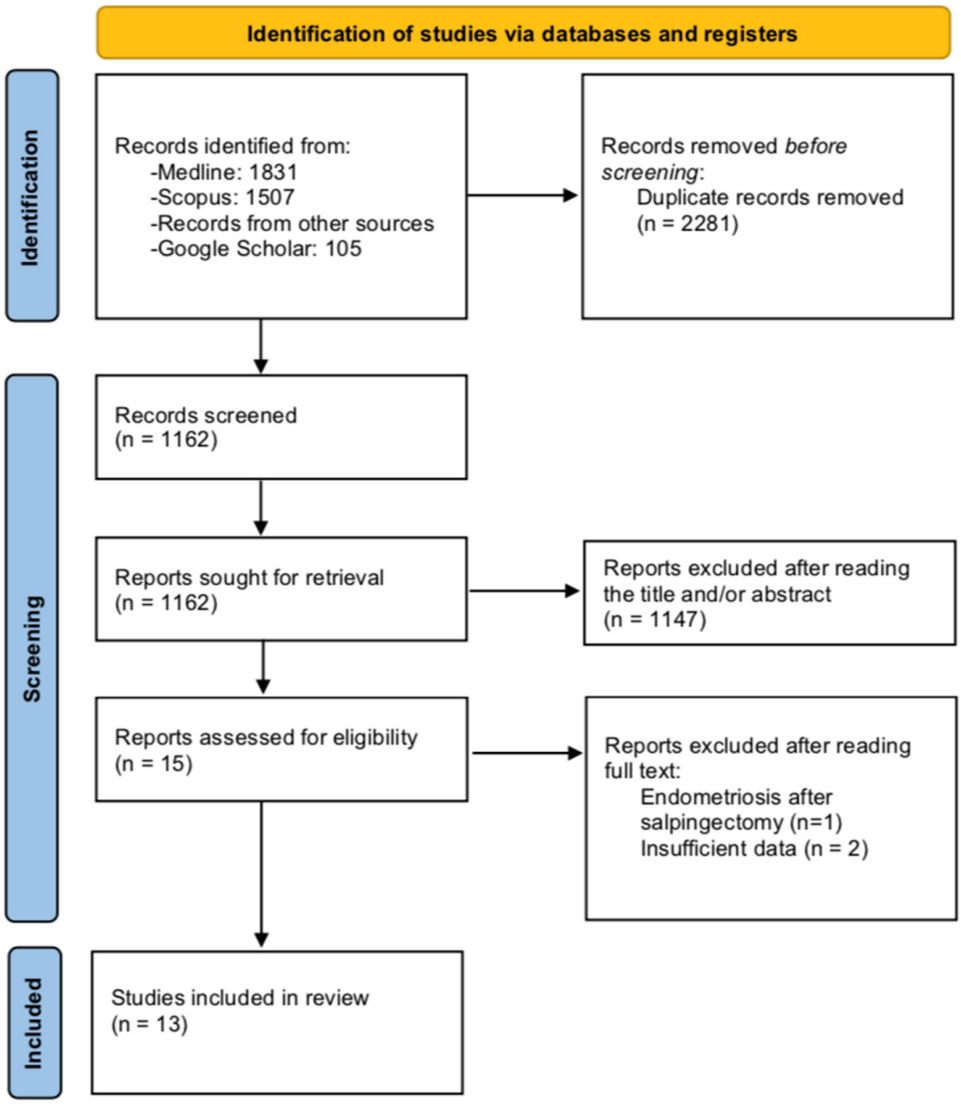

Figure 1. Search flow diagram.

4. Prevalence and Disease Characteristics

Table 1 depicts the main study and patient characteristics derived from the included observational studies.

The prevalence of tubal EM ranged from 9% to 68.6% among the included studies. According to the prospective study by Xia et al., the prevalence of tubal EM in a group of 35 patients with pelvic EM was 68.6% (*n* = 24) [15]. In the study by Qi et al., 1112 premenopausal women who underwent salpingectomy due to various gynecological indications were grouped to those with and without tubal EM and analyzed [16]. In their study, the prevalence of tubal EM was 14.48% (*n* = 161/1112) [16]. The retrospective study by Xue et al. separated patients with tubal EM into three groups: those with EM (*n* = 178), those with other benign diseases (*n* = 65) and 18 others with malignant gynecologic diseases [17]. The prevalence of tubal EM was highest in the EM group. McGuinness et al. assessed the incidence of tubal EM among women who underwent operative laparoscopy due to EM, pelvic pain, infertility or adnexal cystic masses [18]. Ninety-seven patients underwent salpingectomy, whereas in 88 others, the macroscopic

recognition of fallopian tube endometriotic lesions were ablated with CO_2 laser, or electrosurgery (non-salpingectomy group). Tubal EM was detected in 35% (n = 34/97) and in 9% (n = 8/88) in the salpingectomy and non-salpingectomy groups, respectively, while the respective proportions in the subgroup of 153 patients with EM, was 42.5% for histologically proved tubal EM, and 11–12% for macroscopic tubal disease [18].

According to McGuinness et al., tubal EM was significantly related to severe disease when compared to mild or moderate (p = 0.0196) [18]. The same was also observed in the study by Qi et al., who reported an increment in tubal EM prevalence as the severity of pelvic EM increased (r = 0.26, $p < 10^{-4}$) [16]. Regarding the factors that were related to elevated tubal EM rates, tubal ligation, abnormal uterine bleeding and previous surgery for EM were found significant in both uni- and multivariate analysis [16]. Additionally, patients with multi-organ EM presented an increased incidence of tubal EM compared to those with single-organ (43.94% vs. 24.24%, $p < 0.05$) [16].

Left side tubal EM was more prevalent than right side as proved by Qi et al. and Xue et al. (52.17% vs. 40.37%, $p < 0.05$ and n = 168/261, 64.37% vs. n = 93/ 261, 35.63%, $p < 0.001$, respectively) [16][17]. This was also observed when patients who were operated due to EM and malignant diseases were separately analyzed ($p < 0.001$ and $p < 0.05$, respectively) [17].

The literature search revealed a total of 7 case reports during the study period [21][22][23][24][25][26][27]. **Table 2** depicts the main patients' and disease-related characteristics from case reports. Median patients' age was 33 years (range: 18–60), while five out of six patients were nulliparous. All patients were premenopausal except a case of detection of tubal EM in a 60-year-old postmenopausal woman who was diagnosed with clear-cell stage IIIC fallopian tube carcinoma associated with an endometriotic tubal wall cyst. Only one patient reported a history of EM prior to surgery.

5. Histopathological Findings

The analysis of patients by Xia et al. revealed significantly decreased ciliary beat frequency (CBF) in both ampulla and isthmus when compared to either 20 control patients who underwent surgery for uterine leiomyoma or the remaining 11 without EM (non-tubal EM group) [15]. The same was also observed in the percentages of ciliated cells. Finally, tubal EM group presented significantly lower contraction frequencies and weaker muscular contractility [15]. Concerning the histopathological findings reported by Qi et al., mucosa and serosa were the most common layers of tubal EM detection with more than 80% of the proximal tubal lesions detected in the mucosa, whereas 53.85% of lesions in the distal tube were found in the serosa [16]. Finally, serosal lesions presented a more prominent inflammatory reaction and fibroblasts and collagenous proliferation near the lesion than mucosal ones [16].

6. Genetic Background

The study group by Qi et al. recently published two studies on the analysis of the genetic profile of tubal EM [19][20]. More specifically, a study published in 2019 compared the miRNA-microarray expression among four patients with

tubal EM and five controls [19]. The authors identified a total of 17 miRNAs in the tubal epithelium that were expressed different in the tubal EM group (four upregulated and 13 downregulated) [19]. Bioinformatic analysis revealed that some of the detected miRNAs play a significant role in the mTOR signaling pathway, SNARE interactions and endocytosis, thus participating in the pathogenesis of EM [19]. Accordingly, a study published in 2020 by the same study group found a total of 50 significantly dysregulated genes in the tubal epithelial analysis of four women with tubal EM compared to specimens of four controls without tubal EM, while a respective proteomic analysis of tubal fluid showed 33 over-expressed proteins and 19 under-expressed ones in patients with tubal EM [20]. Among them, IL-6, TNFA, C2, C4B, MMP7 and AHSG are common proteins that were found to be preferentially expressed in patients with tubal EM both in epithelium and tubal fluid [20]. Additionally, ORM2, SAA4, CP HP and MAP2K6 are some further innovative proteins that have also been identified [20]. IL-6, C4B, CP, C2, HP, TNFA and ORM2 were among the up-regulated proteins while AHSG and MAP2K6 were the down-regulated ones [20]. The commonly expressed genes and proteins participated in the inflammatory response, cellular movement and immune cell trafficking, which can all explain a part of the molecular mechanisms of EM formation [20].

7. Diagnosis

According to the data derived from case reports, the primary indication for surgery was infertility in three patients. Among them, two had primary infertility and one was a primiparous patient with secondary infertility. The case reported by Kahyaoglou et al., suffered from 18-year infertility and presented with acute pelvic pain and vaginal bleeding 20 days after embryo transfer, and thus referred to emergent laparoscopy with the suspicion of ectopic pregnancy [23]. Acute abdominal pain was also the predominant symptom in two patients who underwent emergent surgery, whereas two other patients reported dull abdominal pain and distention. The preoperative imaging findings and the reported histopathological findings are shown in **Table 2**.

8. Treatment-Follow-Up

All seven patients from the cases reports underwent surgery for the management of their disease. Intraoperative findings revealed that among the five patients with no previous EM history, EM implants were identified during surgery in four of them, while in one patient no intraoperative EM lesions were macroscopically detected. The last patient underwent surgery for suspected hydrosalpinx, and no EM signs were present at macroscopic examination during diagnostic laparoscopy, while histological examination of the excised right tube revealed intraluminal tubal EM. Five patients had laparoscopic approach and the remaining two underwent laparotomy. In four patients the tubal EM lesion was right-sided, in one a left tubal EM was detected and two other had bilateral EM tubal lesions. Five patients aged from 18 to 34 years underwent salpingectomy to manage their disease, whereas two patients aged 49 and 60 years underwent total abdominal hysterectomy (TAH) with right salpingo-ophorectomy, and (TAH) with bilateral salpingo-ophorectomy, pelvic lympadenectomy and para-aortic lympadenectomy, respectively. From the five patients that had salpingectomy, follow-up was available for two of them with both being disease-free with no evidence of EM recurrence at follow up [21][22].

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