

SYSTEMATIC REVIEW

The role of omentectomy in the surgical management of mucinous and serous borderline ovarian tumors

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Abstract

Background: This systematic review evaluates the role of omentectomy in borderline ovarian tumors (BOTs), particularly mucinous BOTs (mBOTs). Considering the differences in the prevalence of omental disease between serous BOTs (sBOTs) and mBOTs, the necessity of omentectomy in mBOTs is controversial. **Methods:** A systematic literature search was conducted using two electronic databases—PubMed and Scopus—following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 guidelines. Studies providing data on omentectomy in BOTs were included in this review. **Results:** A total of 40 studies involving over 7000 patients were included. Among the 37 studies that reported performing omentectomy, 19 (51.4%) reported the presence of omental disease: with sBOT in 15 studies (78.9%) and with mBOT in 3 studies (15.8%) and the rest did not report the BOT subtype. The highest rate of omental disease in mBOT patients was reported at 5.4% in one study. No cases of upstaging due to omental involvement were observed in mBOT patients. Also, the prevalence of peritoneal implants seem to be higher in sBOTs than in mBOTs. The impact of omentectomy on recurrence and survival varied between studies. The higher recurrence rates are reported among patients undergoing fertility-sparing surgery but no significant difference in survival is seen. **Conclusions:** Omentectomy may not be necessary for mBOT patients due to the low risk of omental disease. Omentectomy remains essential for sBOT patients due to the higher risk of extra-ovarian disease in the omentum. **The PROSPERO Registration:** CRD420251139223.

Keywords

Borderline ovarian tumors; Omentectomy; Serous borderline ovarian tumors; Mucinous borderline ovarian tumors; Surgical staging

1. Introduction

Borderline ovarian tumors (BOTs) are epithelial tumors of the ovary that account for 10%–15% of such cases [1, 2]. BOTs are characterized by cellular proliferation and nuclear atypia but exhibit at most stromal microinvasion [3]. The two most common subtypes are serous BOTs (sBOTs) and mucinous BOTs (mBOTs), accounting for 95% of all BOTs [3]. Extra-ovarian disease associated with BOTs is referred to as extra-ovarian implants, which are often found in the omentum and other peritoneal surfaces [4].

BOTs were first described by Taylor in 1929 as semi-malignant ovarian tumors. In 1971, the International Federation of Gynecology and Obstetrics (FIGO) recognized BOTs as “low malignant potential” tumors [3]. Subsequently, in 1973, the World Health Organization (WHO) classified BOTs as a distinct type of ovarian tumors, separate from both benign and malignant categories [3]. The current 2020 WHO classification of female genital tumors defines BOTs as non-invasive epithelial tumors with a stratified growth pattern, characterized by excellent prognosis [3].

BOTs have higher survival rates compared to malignant ovarian tumors [5]. BOTs are primarily diagnosed in young women of reproductive age, with the median age of onset reported as 45 years [1]. About 75% of BOTs are diagnosed at FIGO stage I, with a five-year survival rate of approximately 95% [1]. At the moment, recommended treatment for BOT is complete surgical staging, including peritoneal washing, hysterectomy, bilateral salpingo-oophorectomy, infracolic omentectomy, and resection of macroscopically visible peritoneal lesions [5, 6]. For patients who desire fertility preservation, conservative surgery can be applied [5], where the uterus and at least one of the ovaries are preserved (*i.e.*, fertility-sparing surgery (FSS)) [2]. However, it has also been suggested that uterine-preserving surgery could be recommended in all BOT patients since, according to a previous systematic review, uterine preservation surgery can result in recurrence [7].

BOTs often present nonspecific clinical symptoms, such as abdominal pain or discomfort and bloating. Preoperative diagnostics are limited by the lack of precise diagnostic imaging studies [5, 6], and BOTs are usually diagnosed intraoperatively

with frozen sections [5]. However, approximately one-third of BOTs are misdiagnosed during the primary surgery, leading to incomplete initial staging [6].

Extra-ovarian disease is mainly associated with sBOT, and sBOT implants are categorized into invasive and noninvasive subtypes, with invasive implants related to a worse prognosis [4]. As the omentum is one of the most common sites for these implants, its involvement is determined by pathologic examination of surgical omentectomy specimens [8]. In contrast, mBOTs are usually diagnosed at an early stage (FIGO stage I) and confined to the ovary [9, 10]. Moreover, the term implant should not be used in mBOTs, as extra-ovarian disease should be considered metastasis according to the European Society for Medical Oncology and European Society of Gynecological Oncology (ESMO-ESGO) consensus guidelines [11]. Surgical staging in mBOTs is questionable, as the current guidelines do not account for the differences between different BOT subtypes [10].

This systematic literature review aimed to evaluate the role of omentectomy in the surgical management of BOTs, specifically mBOTs. Furthermore, this review examined the significance of surgical staging in this context, along with the impact of omental disease on disease management and clinical outcomes. By addressing these aspects, this review aims to improve clinical decision-making in BOT treatment.

2. Methods

This systematic review follows the PRISMA 2020 guidelines [12] to ensure transparent, comprehensive, and accurate reporting (**Supplementary material 1**). The systematic review was registered with PROSPERO (registration number: CRD420251139223).

2.1 Information sources and search strategy

A systematic literature search was conducted in September 2024 using two electronic databases, PubMed and Scopus, to retrieve relevant studies published from their inception to September 2024. The search strategy was standardized across both databases, focusing on studies related to BOTs and the omentum. The search terms included “borderline ovarian tumors” and “omentum”, along with additional terms of neoplasms (*e.g.*, neoplasm, tumor, tumour) and surgical management (*e.g.*, omentectomy, removal, resection). Boolean operators “AND” and “OR” were used to refine the search and ensure comprehensive retrieval of relevant studies. The search strategy was designed to capture a broad range of studies addressing the clinical significance of omentectomy and its role in BOT management. The database search strategies are presented in Table 1.

2.2 Data selection, extraction, and management

The search results were imported into Covidence software (<https://www.covidence.org/>) for systematic screening. Covidence is an online tool that automatically identifies and excludes duplicates from both databases, with additional

duplicates manually excluded during the screening process. The screening was conducted independently by two reviewers (Samuel Haataja & Elina Urpilainen) in two stages: (1) title and abstract screening and (2) full-text review. Any disagreements were resolved through discussion until a consensus was reached.

Studies were included if they provided information on the omentum and omentectomy in the BOT context. Inclusion criteria included publications in English, appropriate study designs, and relevance to the research question. Exclusion criteria included non-English publications, an inappropriate study design (*e.g.*, case reports, meta-analyses), and a lack of information on the omentum or omentectomy. Additionally, studies that did not explicitly address the omentum’s role in BOT management were excluded from the final analysis (Fig. 1). The following information was collected from each study: (1) number of patients, (2) BOT subtype, (3) completeness of staging, (4) definition of omentectomy, (5) omentectomy, (6) peritoneal biopsies, (7) recurrence and survival outcomes, and (8) additional relevant results.

2.3 Assessment of methodological quality and risk of bias

The database search identified 25 cohort studies and 15 case series. The number of cases in some case series was small, but cohort studies tended to be considerably larger. The inclusion and exclusion criteria for BOT cases and the definition of omentectomy varied between studies. Only three studies discussed possible bias extensively, and publication bias was difficult to estimate. However, no studies were excluded based on these reasons.

Methodological quality was assessed using the relevant Joanna Briggs Institute critical appraisal checklists for cohort [13] and case series [14] study designs. This included an examination of the study population selection method, measures of outcome and relevant exposures, identification and management of potential confounding variables, validity and reliability of the outcome measurement, and follow-up strategies [13, 14].

Methodological quality varied between studies. Inclusion and exclusion criteria were specified; however, confounding factors were not defined or addressed in most studies. There were considerable variations in how to handle follow-up. Some studies experienced a significant loss in follow-up, and the reasons for this were not adequately described or explored. An assessment of individual studies can be found in **Supplementary Tables 1 and 2**.

3. Results

3.1 Study identification and selection

A total of 548 studies were identified from PubMed and Scopus. After removal of duplicates (both automatically and manually), 412 studies were included in title and abstract screening. Following this, 76 studies were selected for full-text review, resulting in the inclusion of 40 studies in the final analysis. The most common reasons for exclusion during the screening process were a wrong study design ($n = 12$), the full

TABLE 1. Database search phrases.

Database	Search phrases
PubMed	((borderline) AND (ovarian neoplasm* OR ovarian tumor*)) AND (omentectomy OR omentum removal OR omentum)
Scopus	((borderline) AND (ovari* AND (neoplasm* OR tumor* OR tumour*))) AND (oment* OR omentectomy OR (omentum AND removal))

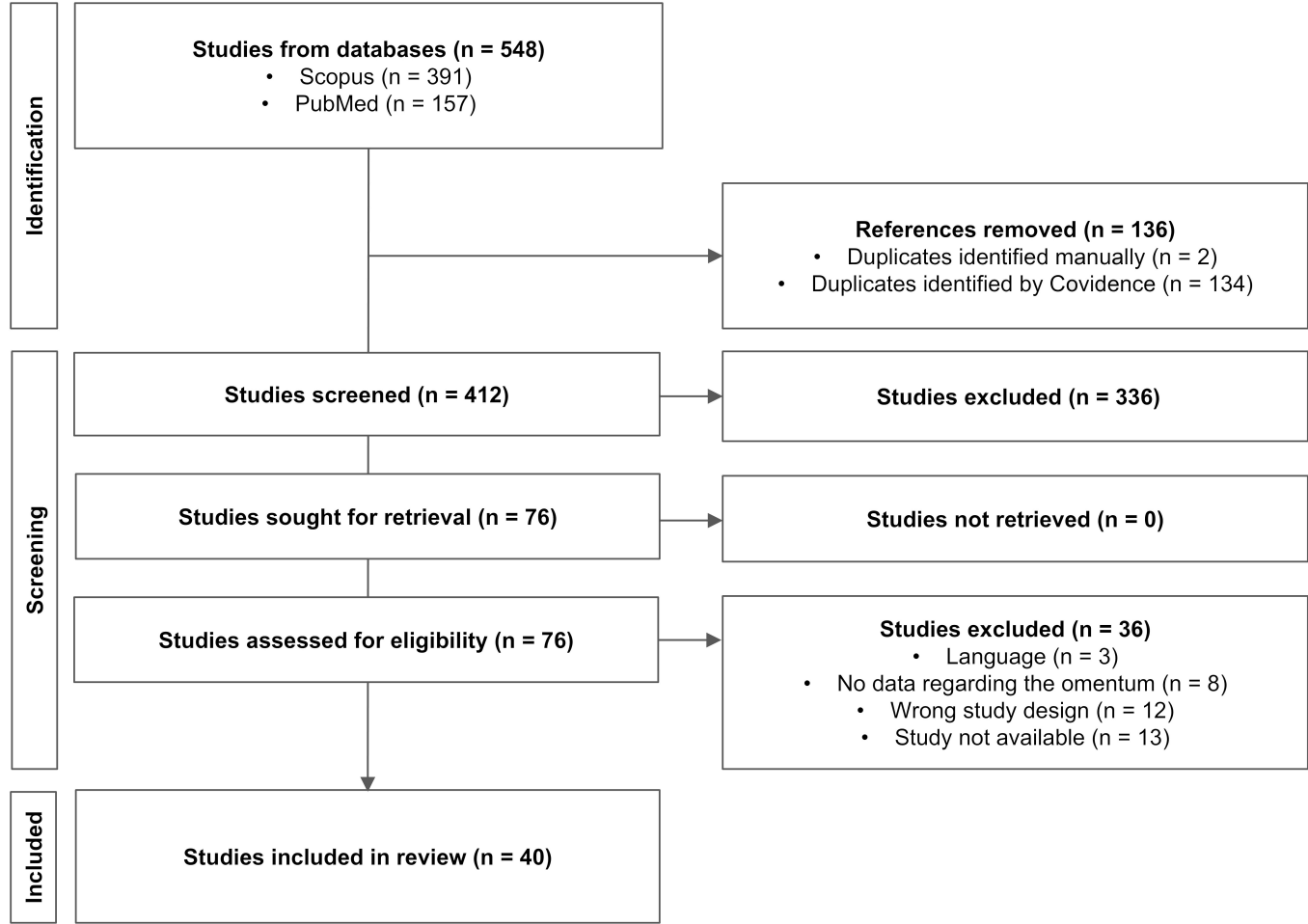


FIGURE 1. Flow chart. Identification of studies and the screening process.

text being unavailable (n = 13), and a lack of relevant data regarding the omentum (n = 8).

3.2 Characteristics of included studies

A total of 40 studies (Supplementary Table 3 (Ref. [1, 2, 4–6, 8–10, 15–46])) were included in this systematic literature review, published between 1993 and 2024, with three publications from the 20th century. All studies were published in English. Most were conducted in Europe (n = 20), with some in North America (n = 7) and Asian countries (n = 6). The study periods in the included studies ranged from 1965 to 2022.

3.3 Omentectomy and omental disease in sBOTs and mBOTs

International guidelines recommend performing omentectomy as a part of surgical staging for BOTs [11]. Among the 40

studies included in this review, 39 (97.5%) reported performing omentectomy or other surgical procedures involving the omentum. Eleven reported performing infracolic omentectomy, while 23 reported performing omentectomy without further specification. Omental biopsies were performed in nine studies. Other surgical procedures, such as greater omentum resection [26, 31, 39], omental excision [34], and partial omentectomy [30], were less common. Omentectomy data were collected regardless of whether it was performed during initial or restaging surgery (Supplementary Table 3). There were no frozen sections done from the omentum in any of the included studies. In one study concerning FSS reported less pregnancies after omentectomy [1]. The other studies did not report complications in terms of omentectomy.

In studies reporting omentectomy separately for sBOTs and mBOTs, it was performed more frequently for sBOT patients. In Bendifallah *et al.*'s [2] study, omentectomy was performed

in 42.9% of sBOT patients compared to 12.9% of mBOT patients. Guo *et al.* [5] and Şahin *et al.* [39] reported similar findings, with omentectomy rates of 74.6% and 52.4%, and 71.1% and 41.2%, for sBOT and mBOT patients, respectively. In Zilliox *et al.*'s [46] study, omentectomy was performed for all seven sBOT and six mBOT patients included. Kavak Cömert *et al.* [9], De Decker *et al.* [10], and Gungorduk *et al.* [23] only included mBOT patients, with 53.3%, 62.2%, and 40.1% omentectomy rates, respectively. In 17 studies, the number of performed omentectomies was not reported separately by subtype (**Supplementary Table 3**).

Among the 37 studies that reported performing omentectomy, 19 (51.4%) reported the presence of omental disease: with sBOT in 15 studies (78.9%) and with mBOT in 3 studies (15.8%). In three studies, omental disease was observed without further specifying the subtype [22, 24, 39]. In seven studies including both sBOT and mBOT patients, omental disease was exclusively or more frequently observed in patients with sBOT [2, 4–6, 16, 19, 29]. In four of these studies, omental disease was observed solely in sBOT patients [4, 16, 19, 29]. Examining both sBOT and mBOT patients, Bendifallah *et al.* [2] and Guo *et al.* [5] observed higher omental disease rates in sBOT patients. Bendifallah *et al.* [2] reported omental involvement in 45.1% of sBOT compared to 3.5% of mBOT patients who had undergone omentectomy. Similarly, Guo *et al.* [5] found omental involvement after performing omentectomy in 18.3% of sBOT and 5.4% of mBOT cases (**Supplementary Table 3**).

Four studies exclusively included mBOT patients [9, 10, 23, 27]. Kavak Cömert *et al.* [9] and De Decker *et al.* [10] found no omental disease among the 40 and 44 patients who had undergone omentectomy, respectively. Gungorduk *et al.* [23] reported omental disease in 3 of 163 (1.8%) patients who had undergone omentectomy. Jung *et al.* [27] did not report the results of the omentectomy procedure performed. The omental disease rate among mBOT patients was similarly low in other studies, with Guo *et al.* [5] reporting the highest rate at 5.4% (**Supplementary Table 3**).

Guo *et al.* [5] found that patients undergoing omentectomy were more frequently diagnosed at higher FIGO stages, and omental and peritoneal implants were significantly more common in sBOT patients compared to other subtypes. Similarly, Trillsch *et al.* [41] reported patients undergoing omentectomy diagnosed at higher FIGO stages and presenting with more peritoneal implants. In contrast, Lecointre *et al.* [31] found no association between infragastric omentectomy and the FIGO stage of the tumor. Kristensen *et al.* [4] observed advanced-stage tumors only in sBOTs. Regarding the location of extra-ovarian disease, Şahin *et al.* [39] found the omentum to be the most frequent site of BOT implants. In contrast, Gungor *et al.* [24] found the omentum and appendix to be the least involved organs.

3.4 Omental disease and upstaging

Seven studies reported upstaging due to omental disease [4–6, 16, 28, 29, 38], all exclusively in sBOT patients. Among the four studies that included only mBOT patients, Jung *et al.* [27] reported upstaging in 16 (4.4%) patients in the staging group

but did not provide data regarding the extra-ovarian disease location.

Guo *et al.* [5] found that upstaging was more frequent in sBOTs compared to non-sBOTs, highlighting a significant difference. Similarly, Kristensen *et al.* [4] and Daraï *et al.* [6] found a higher risk of upstaging in sBOT patients. Daraï *et al.* [6] specifically reported a higher risk of upstaging in sBOT patients with initial FIGO stage I or II disease. Kristensen *et al.* [4] and Camatte *et al.* [16] observed omental upstaging only in sBOT patients. Kristensen *et al.* [4] found noninvasive implants in the omentum, leading to the upstaging of three sBOT patients with presumed stage I disease and one sBOT patient with presumed stage II disease to stage IIIA. Kane *et al.* [28] and Nezhat *et al.* [38] exclusively studied sBOT patients and found upstaging due to omental disease. Kane *et al.* [28] reported that 4 of 18 sBOT patients with initial stage I disease were upstaged to stage IIIA due to microscopic implants found on the omentum or in the peritoneal biopsy.

3.5 Peritoneal biopsies and peritoneal implants

The ESMO-ESGO consensus guidelines recommend using the term metastasis for extraovarian disease in mBOT, while the term implant should be used for sBOT [11]. Three studies exclusively included sBOT patients with peritoneal implants [20, 21, 39]. Of the 37 other studies, peritoneal biopsies were performed in 28 (75.7%). Peritoneal biopsies were more frequently performed in sBOT compared to mBOT patients. For example, Bendifallah *et al.* [2] reported peritoneal biopsies performed for 76.4% of sBOT patients, compared to 34.7% of mBOT patients. Similarly, Şahin *et al.* [39] reported biopsies performed for 71.1% and 41.2% of sBOT and mBOT patients in the staging group, respectively. Data on peritoneal biopsy rate by subtype were not available in most studies (Table 2, Ref. [1, 2, 4–6, 8–10, 16–46]).

In the four studies exclusively including mBOT patients [9, 10, 23, 27], peritoneal metastases were observed only in Gungorduk *et al.*'s [23] study, with noninvasive implants found in 12 of 364 patients (3.3%). Jung *et al.* [27] reported performing peritoneal biopsies but reported no results [27] (Table 2).

In seven studies including both sBOT and mBOT patients, the prevalence of peritoneal implants was higher, or peritoneal implants were only observed in sBOT [2, 4, 16, 24, 29, 39, 45]. Bendifallah *et al.* [2] observed peritoneal implants in 30.2% of sBOT and 6.7% of mBOT patients with peritoneal biopsies performed. Şahin *et al.* [39] reported peritoneal implants in 13 of 76 (17.1%) sBOT and 2 of 51 (3.9%) mBOT patients, with invasive implants only seen in sBOTs. However, data on peritoneal biopsy rate were not available in this study. Similarly, Westermann *et al.* [45] reported peritoneal implants in 101 of 312 (32.4%) sBOT and 2 of 129 (1.6%) mBOT patients, with invasive implants only seen in sBOTs and peritoneal biopsies performed for 93.9% of the whole study population (Table 2).

Kristensen *et al.* [4] found noninvasive implants in sBOT patients only. In contrast, Fotopoulou *et al.* [22] reported higher rates of invasive peritoneal implants in mBOT compared to sBOT patients (33.3% vs. 12.8%), while noninvasive

TABLE 2. Peritoneal biopsies and peritoneal implants in borderline ovarian tumors (BOTs).

Author (First)	Year	Number of BOT cases (n)	BOT subtype (n, %)	Peritoneal biopsies	Peritoneal implants
Bendifallah [2]	2016	n = 428	sBOT: 212 (49.5%) mBOT: 216 (50.5%)	Total: 237/428 (55.4%) sBOT: 162/212 (76.4%) mBOT: 75/216 (34.7%)	Total: 54/237 (22.8%) sBOT: 49/162 (30.2%) mBOT: 5/75 (6.7%)
Camatte [16]	2004	n = 101	sBOT: 60 (59.4%) mBOT: 30 (29.7%)	Total: 54/101 (53.5%)	Total: 5/54 (8.9%) sBOT: 5/60 (8.3%)
Damak [17]	2014	n = 40	sBOT: 18 (45.0%) mBOT: 21 (52.5%)	-	Total: 8/40 (20.0%)
Daraï [6]	2007	n = 42	sBOT: 17 (40.5%) mBOT: 22 (52.4%)	Total: Performed (N/A)	Total: 2
De Decker [10]	2017	n = 74	mBOT: 74 (100%)	mBOT: 34/74 (45.9%)	mBOT: 0/34 (0%)
Deffieux [18]	2005	n = 9	sBOT: 9/9 (100%) *Stage II/III	sBOT: 9/9 (100%)	sBOT: 9/9 (100%)
Doig [19]	2006	n = 692	sBOT: ≥ 1	-	-
Falcone [20]	2021	n = 91	sBOT: 91 (100%) *Stage II/III	Patients with extra-ovarian implants were included	sBOT: 100%
Falcone [21]	2022	n = 13	sBOT: 13 (100%) *Stage II/III	Patients with extra-ovarian implants were included	sBOT: 100%
Fotopoulou [22]	2009	n = 51	sBOT: 39 (76.5%) mBOT: 12 (23.5%)	Total: 46/51 (90.2%)	Total: 20/46 (60.6%) sBOT: 15/39 (38.5%) mBOT: 5/12 (41.7%)
Gungorduk [23]	2017	n = 364	mBOT: 364 (100%)	mBOT: $\geq 92/364$ ($\geq 25.3\%$)	mBOT: 12/364 (3.3%)* % of all patients
Gungor [24]	2014	n = 183	sBOT: ≥ 67 mBOT: ≥ 33	Total: Performed (N/A)	Total: 9/183 (4.9%)* sBOT: 5 mBOT: 2
Guo [5]	2023	n = 901	sBOT: 389 (43.2%) mBOT: 452 (50.2%)	Total: $\geq 478/901$ ($\geq 53.1\%$)	Total: Positive (N/A)
Guvenal [25]	2013	n = 539	sBOT: 332 (61.6%) mBOT: 170 (31.6%)	Total: $\geq 228/539$ ($\geq 42.3\%$)	-
He [26]	2022	n = 247	sBOT: 102 (41.3%) mBOT: 75 (30.4%)	-	-
Jung [27]	2020	n = 432	mBOT: 432 (100%)	mBOT: Performed (N/A)	mBOT: 1/432 (0.2%)
Kærn [15]	1993	n = 370	sBOT: 174 (47%) mBOT: 178 (48%)	-	-
Kane [28]	2010	n = 18	sBOT: 18 (100%) *Stage II/III	sBOT: 18/18 (100%)	sBOT: 18/18 (100%)
Kavak Cömert [9]	2016	n = 75	mBOT: 75 (100%)	mBOT: 3/75 (4.0%)	mBOT: 0/3 (0%)
Kristensen [4]	2014	n = 75	sBOT: 51 (68.0%) mBOT: 23 (30.7%)	Total: Performed (N/A)	Total: Positive (N/A) sBOT: 16/51 (31.4%)
Kumpulainen [29]	2007	n = 65	sBOT: 37 (57%) mBOT: 27 (42%)	Total: 16/65 (24.6%)	Total: Positive sBOT only (N/A)
Lackman [30]	2003	n = 16	sBOT: 16 (100%) *Stage II/III	sBOT: 14/16 (87.5%)	sBOT: 14/14 (100%)
Lecointre [31]	2021	n = 332	sBOT: 175 (52.7%) mBOT: 144 (43.4%)	Total: 273/332 (82.2%)	Total: 54/332 (16.3%)
Lin [32]	1999	n = 255	sBOT: 255 (100%)	sBOT: 74/255 (29.0%)	sBOT: 62/74 (83.8%)
Loizzi [33]	2015	n = 55	sBOT: 33 (60.0%) mBOT: 18 (32.7%)	Total: 27/55 (49.1%)	Total: 2/27 (7.4%)

TABLE 2. Continued.

Author (First)	Year	Number of BOT cases (n)	BOT subtype (n, %)	Peritoneal biopsies	Peritoneal implants
Lu [34]	2019	n = 19	sBOT: 19 (100%) *Stage II/III	sBOT: 17/19 (89.5%)	sBOT: 17/17 (100%)
Menczer [35]	2012	n = 225	sBOT: 149 (66.7%) mBOT: 67 (29.8%)	-	-
Muzii [36]	2009	n = 27	No data	-	-
Nasioudis [37]	2017	n = 114	sBOT: 61 (53.5%) mBOT: 51 (44.8%)	-	-
Nezhat [38]	2009	n = 36	sBOT: 11 (100%)	sBOT: Performed (N/A)	-
Qi [1]	2021	n = 394	sBOT: 228 (57.9%) mBOT: 113 (28.7%)	Total: Performed (N/A)	Total: Positive (N/A)
Şahin [39]	2021	n = 147	sBOT: 76 (51.7%) mBOT: 51 (34.6%)	Total: ≥88/147 (≥59.9%) sBOT: ≥54/76 (≥71.1%) mBOT: ≥21/51 (≥41.2%)	Total: 15/147 (10.2%)* sBOT: 13/76 (17.1%) mBOT: 2/51 (3.9%)
Shih [40]	2010	n = 80	sBOT: 80 (100%) *Stage II–IV	Patients with extra-ovarian implants were included	sBOT: 80/80 (100%)
Skala [8]	2015	n = 44	sBOT: 7 (100%)	-	-
Trillsch [41]	2015	n = 559	sBOT: 559 (100%)	sBOT: 374/559 (66.9%)	sBOT: 131/374 (35.0%)
Ureyen [42]	2016	n = 162	sBOT: 162 (100%)	sBOT: 30/121 (24.8%)	sBOT: 18/30 (60.0%)
Uzan [43]	2012	n = 16	eBOT: 16 (100%)	eBOT: 8/16 (50.0%)	eBOT: 0/8 (0%)
Weir [44]	1998	n = 40	sBOT: 19 (100%)	-	-
Westermann [45]	2024	n = 507	sBOT: 312 (61.5%) mBOT: 129 (25.4%)	Total: 476/507 (93.9%)	Total: Positive (N/A) sBOT: 101 (32.4%) mBOT: 2 (1.5%)
Zilliox [46]	2021	n = 14	sBOT: 7 (50.0%) mBOT: 6 (42.9%)	Total: 14/14 (100%)	Total: Positive (N/A) sBOT: 1/7 (14.3%)

sBOT: serous borderline ovarian tumor; mBOT: mucinous borderline ovarian tumor; eBOT: endometrioid borderline ovarian tumor; N/A: Not available.

* of all sBOT and mBOT patients.

implants were more frequently observed in sBOT patients (25.6% vs. 8.3%). Peritoneal biopsies were performed for 46 of the 51 patients [22]. Regarding both peritoneal and omental findings, Guo *et al.* [5] found that both omental and peritoneal implants were more common in women with sBOT, with a statistically significant difference. Similarly, Kumpulainen *et al.* [29] observed peritoneal and omental implants in sBOT patients only.

3.6 Recurrence and survival outcomes

Recurrences were observed in 35 studies. In eight studies, recurrences were observed only in sBOT patients or were more frequent in sBOT compared to mBOT patients, with recurrence rates ranging from 3.9% to 29.2% in sBOT and 2.0% to 14.8% in mBOT [1, 2, 5, 16, 24, 31, 39, 45]. In contrast, two studies reported a higher recurrence rate in mBOT patients: Damak *et al.* [17] (38.1% vs. 27.8%) [17] and Kærn *et al.* [15] (10.1% vs. 4.0% [15]; **Supplementary Table 3**).

Among studies exclusively including mBOT patients, recurrences were observed in three out of four studies. Kavak Cömert *et al.* [9] observed one recurrence among 75 pa-

tients (1.3%) with no deaths during a 51-month follow-up. Gungorduk *et al.* [23] reported recurrence in 24 out of 364 mBOT patients (6.6%), with no significant difference between recurrence and completeness of staging. Jung *et al.* [27] reported recurrence rate of 3.5% in 432 patients, while De Decker *et al.* [10] observed no recurrences in mBOT patients (**Supplementary Table 3**).

In advanced-stage BOTs, recurrence rates were higher. Westermann *et al.* [45] reported recurrence rate of 5.9% for FIGO stage I patients compared to 40.0% for FIGO stages II–IV patients with a significant difference. Bendifallah *et al.* [2] reported recurrence rates of 19.1%, 33.3% and 29.7% for patients with FIGO stages I, II, and III BOT, respectively. In a study by Shih *et al.* [40], 21% of patients with advanced-stage sBOT experienced recurrence, while Falcone *et al.* [20, 21] reported recurrence rates of 54.0% and 85.0%, respectively, in patients with advanced stage (FIGO stages II and III) sBOTs. Shih *et al.* [40] reported that only patients with omental disease or metastases to multiple sites developed recurrent disease, with a recurrence rate of 28.0% (**Supplementary Table 3**).

Results regarding the impact of omentectomy on recurrence and survival varied between studies. Qi *et al.* [1] found omentectomy to have no effect on recurrence. Gungorduk *et al.* [23] reported no differences in progression-free survival or overall survival (OS) in patients undergoing omentectomy. Nasioudis *et al.* [38] reported no advantage in OS for patients with stage I BOT undergoing omentectomy. In this study, five-year OS rates for sBOT and mBOT patients were 66.4% and 84.5%, respectively [37]. Menczer *et al.* [35] also found no difference between omentectomy and OS. In contrast, Trillsch *et al.* [41] found omentectomy to be associated with improved progression-free survival, even when adjusting for FIGO stage. Similarly, Bendifallah *et al.* [2] observed improved five-year OS with complete staging.

Regarding surgical staging in general, Guvenal *et al.* [25] found no difference in survival rates based on the extensiveness of surgical staging. Similarly, Guo *et al.* [5] found no significant difference in recurrence rates between complete and incomplete surgical staging (14.0% vs. 13.7%). However, complete surgical staging was associated with significantly lower recurrence rate in FIGO stage > I patients (26.0 vs. 44.8%), while no significant difference was observed in FIGO stage I patients [5]. Şahin *et al.* [39] found that surgical staging or presence of implants were not associated with recurrence. Regarding peritoneal biopsies, Camatte *et al.* [16] found that lack of complete peritoneal staging in presumed stage I BOTs increased recurrence rates. Falcone *et al.* [21] observed that invasive peritoneal implants had impact on disease-free survival (DFS) but had no effect on OS.

3.7 Surgical approach: staging, conservative treatment, and surgical route

Of the 40 included studies, 16 (40%) reported performing complete surgical staging, including omentectomy and peritoneal biopsies (Supplementary Table 3 and Table 2). Both laparoscopic and laparotomic approaches were used in 18 studies [1, 2, 5, 6, 9, 16, 20–23, 26, 30, 31, 33, 34, 41, 43, 46]. Several studies reported performing conservative surgery, also referred to as FSS, generally defined as preserving the uterus and at least one ovary [1, 2, 5, 9, 16–18, 20, 21, 23–26, 28, 29, 34, 38, 41–43, 46].

FSS on recurrence and survival was evaluated. Kristensen *et al.* [4] and Gungorduk *et al.* [23] found no significant association between FSS and recurrence, while six studies reported higher recurrence rates in FSS patients, compared to non-FSS patients [1, 17, 31, 33, 39, 42]. For example, Qi *et al.* [1] reported higher recurrence rates in patients undergoing FSS compared to non-FSS treatment (10.2% vs. 2.5%), while Lecointre *et al.* [31] reported 17.3% in FSS compared to 3.1% in non-FSS patients. Despite higher recurrence rates, Loizzi *et al.* [33] found no significant difference in OS between the FSS and non-FSS groups.

Regarding surgical staging and survival outcomes, Bendifallah *et al.* [2] reported higher five-year OS in the complete staging group compared to incomplete staging (98.4% vs. 93.8%). In contrast, Guo *et al.* [5] reported higher five-year OS in the incomplete staging group, despite higher five-year DFS in the complete staging group. Westermann *et*

al. [45] reported significantly shorter DFS after FSS compared to patients undergoing radical surgery. Kristensen *et al.* [4] recommended staging surgery including omentectomy for sBOT patients and radical treatment for sBOT patients without fertility-preserving desire. Daraï *et al.* [6] recommended performing restaging operations for sBOT patients.

4. Discussion

This systematic review evaluated the role of omentectomy in the surgical staging of BOTs, particularly mBOTs. While omentectomy is frequently performed as a part of surgical staging, its necessity in mBOT remains controversial, as 90% of mBOTs are diagnosed at FIGO stage I [9]. Furthermore, the prevalence of peritoneal implants seem to be higher in sBOTs than in mBOTs [2, 4, 16, 24, 29, 39, 45]. The higher recurrence rates are reported among patients undergoing FSS compared to non-FSS [1, 17, 31, 33, 39, 42], but no significant difference in OS is seen [33].

While complete surgical staging is still recommended for all patients with BOTs [11], this has not always applied in real-life practice. Our findings indicate that omentectomy is performed more frequently for sBOT compared to mBOT patients [2, 5, 39]. The presence of omental disease was more frequently observed in sBOT patients, with rates as high as 45.1% in a study with both early- and advanced-stage sBOTs [2]. In contrast, the highest reported rate of omental disease in mBOT was 5.4% [5]. In studies exclusively including mBOT patients, omental disease was observed at lower rates compared to sBOT. Gungorduk *et al.* [23] reported omental disease in only 1.4% of cases, while Kavak Cömert *et al.* [9] and De Decker *et al.* [10] observed no omental disease, despite relatively high rates of complete staging performed (53.3% and 62.2%). These findings emphasize the lower risk of omental disease in mBOT patients.

Several studies highlighted the higher risk of omental disease and upstaging in sBOT patients. Kristensen *et al.* [4] and Trillsch *et al.* [41] found that omental involvement was more common in sBOT patients, with those undergoing omentectomy more frequently diagnosed at higher FIGO stages, reflecting the importance of staging in sBOT patients. Guo *et al.* [5] reported significantly higher rates of omental and peritoneal implants in sBOTs compared to other histologic subtypes. Shih *et al.* [40] reported that only patients with omental disease or metastases to multiple sites developed recurrence, with a 28.0% rate in sBOT patients. These results further support the necessity of omentectomy in sBOT patients.

Recurrence rates were consistently higher in sBOT compared to mBOT, reflecting the more aggressive behavior of sBOT. Eight studies reported higher recurrence in sBOT patients, while only two studies reported higher recurrence in mBOT. Recurrence rates were significantly higher in advanced-stage BOTs, the majority of which were sBOT. Among studies exclusively including mBOT patients, recurrence rates ranged from 1.3% to 6.6%. De Decker *et al.* [10] further noted that recurrence with malignant disease is rare among mBOTs. The association between omentectomy, complete staging, and recurrence varied across studies, but omentectomy did not seem to impact OS. Nasioudis *et al.* [37]

specifically reported no survival benefit from omentectomy in stage I BOTs. As omentectomy does not appear to improve survival outcomes and omental disease is observed at low rates in mBOT, routine omentectomy is controversial.

Some studies questioned the necessity of staging [9, 16], as the discovery of mBOT omental implants does not alter patient management [16]. Bendifallah *et al.* [2] suggested that complete staging, including omentectomy, could be omitted for presumed FIGO stage I BOTs. Some studies proposed alternative approaches. Bendifallah *et al.* [2] and Doig *et al.* [19] suggested that omental biopsies could be a sufficient alternative procedure when the omentum appears grossly normal. This approach could be particularly useful for mBOT patients, as the prevalence of omental involvement is lower. Lecointre *et al.* [31] and Skala *et al.* [8] proposed that alternative staging approaches should be explored for early-stage BOTs to minimize overtreatment while ensuring adequate disease assessment.

This study has some limitations. Several studies provided incomplete data on the number of performed omentectomies and omental involvement by subtype, making it difficult to present definitive conclusions. For example, in Daraï *et al.*'s [6] study, three patients were upstaged due to omental disease—with only one of the seven upstaged patients presenting mBOT, making it difficult to draw conclusions without exact numbers by subtype. Some studies also included more advanced-stage BOT patients, particularly sBOT patients, which may have affected the data regarding recurrence and survival outcomes.

Omentum has an important role in immune responses, wound healing, and tissue regeneration [47]. Furthermore, omentectomy may also increase the risk of postoperative complications such as bleeding, postoperative adhesions and injury to organs close to the omentum [48]. Future research should aim to optimize the surgical staging of mBOT, considering its lower risk of extra-ovarian disease compared to sBOT. Alternative approaches, such as omental biopsies, should be compared to omentectomy to determine whether less invasive approaches can be safely utilized. Clear guidelines are needed to determine when to perform omentectomy, especially if the omentum seems grossly normal.

5. Conclusions

Omentectomy in mBOT patients may not be necessary, as the risk of omental disease is low. Also, the prevalence of peritoneal implants seem to be higher in sBOTs than in mBOTs. As 90% of mBOTs are diagnosed at FIGO stage I and omentectomy seems not to have an impact on survival outcomes, alternative approaches, such as omental biopsies should be further explored. Consistent with the literature, omental disease is significantly more common in sBOT, and omentectomy should be performed as a part of surgical staging, considering the high risk of extra-ovarian disease and the more aggressive nature of sBOT.

ABBREVIATIONS

BOT, borderline ovarian tumor; DFS, disease-free survival; ESMO-ESGO, European Society of Medical Oncology and European Society of Gynecological Oncology; FIGO, the International Federation of Gynecology and Obstetrics; FSS, fertility-sparing surgery; mBOT, mucinous borderline ovarian tumor; OS, overall survival; PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses; sBOT, serous borderline ovarian tumor; WHO, World Health Organization.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article.

AUTHOR CONTRIBUTIONS

SH, ST and EU—contributed to the study conception and design. SH and EU—performed the material preparation, data collection, and analysis. HH—wrote the methodology section and **Supplementary Tables 1 and 2**. SH—drafted the first version of the manuscript. EU and ST—reviewed and refined the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at <https://oss.ejgo.net/files/article/2011677135888891904/attachment/Supplementary%20material.zip>.

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