Published in final edited form as:

J Minim Invasive Gynecol. 2019 January ; 26(1): 87–93. doi:10.1016/j.jmig.2018.04.005.

ACCURACY OF INTRAOPERATIVE FROZEN SECTION DIAGNOSIS OF BORDERLINE OVARIAN TUMORS BY HOSPITAL TYPE

Jaimin Shah, MD¹, Michael Mackelvie, MD¹, David M. Gershenson, MD², Preetha Ramalingam, MD³, Marylee M. Kott, MD⁴, Jubilee Brown, MD², Polly Gauthier, MD⁵, Elizabeth Nugent, MD⁶, Lois M. Ramondetta, MD⁷, and M. Frumovitz, MD, MPH^{2,*}

¹UT-Houston Obstetrics and Gynecology/McGovern Medical School, Houston, TX

²Department of Gynecologic Oncology and Reproductive Medicine, The University of Texas MD Anderson Cancer Center, Houston, TX

³Department of Pathology, The University of Texas MD Anderson Cancer Center, Houston, TX

⁴Department of Pathology, Lyndon B. Johnson Hospital/UT-Houston, Houston, TX

⁵Department of Pathology, The Woman's Hospital of Texas, Houston, TX

⁶UT-Houston Obstetrics and Gynecology/McGovern Medical School, Department of Gynecologic Oncology, Houston, TX

⁷Department of Gynecologic Oncology, Lyndon B. Johnson Hospital/MD Anderson Cancer Center, Houston, TX

Abstract

Study Objective—To compare the accuracy of frozen section diagnosis of borderline ovarian tumors among three distinct types of hospital—academic hospital with gynecologic pathologists, academic hospital with non-gynecologic pathologists, and community hospital with non-gynecologic pathologists—and to determine if surgical staging alters patient care or outcomes for women with a frozen section diagnosis of borderline ovarian tumor.

Design—Retrospective study

Design Classification—Level II

Setting—Tertiary care, academic, and community hospitals

*Corresponding author: Dr. Michael Frumovitz, Department of Gynecologic Oncology, CPB6.3244, Unit 1362, The University of Texas MD Anderson Cancer Center, 1155 Herman Pressler, Houston, TX 77030, USA. Phone: (713) 592-9599. Fax: (713) 792-7586. mfrumovitz@mdanderson.org.

Conflict of Interest statement: There are no conflicts of interest or disclosures from any authors

Conflict of Interest: Dr. Frumovitz receives research funding from Navidea and Novadaq and honorarium from Novadaq, Genetech, and Johnson and Johnson

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Patients—Women with an intraoperative frozen section diagnosis of borderline ovarian tumor at one of the aforementioned three types of hospital from April 1998 through June 2016.

Interventions—Comparison of final pathology to intraoperative frozen section diagnosis.

Measurements and Main Results—Two hundred twelve women met the inclusion criteria. The frozen section diagnosis of borderline ovarian tumor correlated with the final pathologic diagnosis in 192 of 212 cases (90.6%) and the rate of correlation did not differ among the three hospital types ($P = 0.82$). Seven tumors (3.3%) were downgraded to benign on final pathologic analysis and 13 (6.1%) were upgraded to invasive carcinoma. The three hospital types did not differ with respect to the proportion of tumors upgraded to invasive carcinoma ($P = 0.62$). Mucinous (odds ratio [OR] = 7.1, 95% CI, 2.1–23.7, $P = 0.002$) and endometrioid borderline ovarian tumors (OR = 32.4, 95% CI, 1.8–595.5, $P = 0.02$) were more likely than serous ones to be upgraded to carcinoma. Only 88 patients (41.5%) underwent lymphadenectomy and only 1 (1.1%) had invasive carcinoma in a lymph node.

Conclusions—A frozen section diagnosis of borderline ovarian tumor correlates with the final pathologic diagnosis in a variety of hospital types.

Keywords

Borderline ovarian tumor; ovarian cancer; frozen section; staging; hospital type

INTRODUCTION

Borderline ovarian tumors have been described in the literature for almost a century, but the optimal management strategy for these tumors remains uncertain [1]. Borderline ovarian tumors account for approximately 15% of all primary ovarian neoplasms and often exhibit behavior that is intermediate between that of benign cystadenomas and invasive carcinomas [2,3]. One-third of the women diagnosed with borderline ovarian tumors are younger than 40 years of age, which adds to the complexity of management as one must consider ovarian function and fertility-sparing approaches [4].

Up to one-third of borderline ovarian tumors present as simple or unilocular cysts [5]. Borderline ovarian tumors often have a benign appearance on sonography, and thus they are often managed by general gynecologists and frequently only diagnosed intraoperatively on the basis of a pathologist's review of frozen sections. The accuracy of intraoperative frozen section analysis is crucial as the frozen section diagnosis aids the surgeon with intraoperative decision making with regard to surgical staging and fertility preservation. However, a quantitative systematic review by Medeiros et al [6] concluded that although frozen section analysis "is highly accurate in the diagnosis of benign and malignant ovarian tumors," it is "only moderately useful in the diagnosis of borderline ovarian tumors". As many patients will undergo surgery by a general gynecologist at a community hospital setting, we were interested in determining how intraoperative frozen section in that setting might compare to those in an academic tertiary care hospital or even in a highly specialized National Cancer Institute-designated cancer center. To our knowledge, the quality and accuracy of frozen section in each of those settings have not been compared.

Another important issue in the management of borderline ovarian tumors is the lack of consensus, owing to inconsistent data, regarding optimal surgical procedures to improve overall survival [7]. The role of complete surgical staging and the role of oophorectomy or ovarian preservation remain unclear [2,8]. For patients with stage I borderline ovarian tumors, the 5-year survival rate is 99% and the risk of recurrence with conservative surgery ranges from 7% to 30% [9]. However, whereas some studies show that disease stage has prognostic value in patients with borderline ovarian tumors, other studies do not [7].

When a patient is diagnosed with a borderline ovarian tumor intraoperatively on the basis of frozen section analysis, surgeons may be concerned about an occult invasive carcinoma, leading to further surgical procedures. However, such procedures may increase morbidity without improving the overall prognosis.

The primary aim of this study was to compare the accuracy of frozen section diagnosis of borderline ovarian tumors among three distinct types of hospital: academic hospital with gynecologic pathologists, academic hospital with non-gynecologic pathologists, and community hospital with non-gynecologic pathologists. In addition, we examined practice patterns to determine if surgical staging alters patient care or outcomes for women with a frozen section diagnosis of borderline ovarian tumor.

MATERIALS AND METHODS

This was a retrospective study of patients with an intraoperative frozen section diagnosis of borderline ovarian tumor at any of four hospitals during the period from April 1998 through June 2016. The hospitals were categorized into three distinct groups based on setting and availability of gynecologic pathologists. Group 1 consisted of The University of Texas MD Anderson Cancer Center, an academic hospital with gynecologic pathologists. Group 2 consisted of Memorial Hermann–Texas Medical Center and Lyndon B. Johnson Hospital, two academic hospitals with non-gynecologic pathologists. Group 3 consisted of The Woman’s Hospital of Texas, a community hospital with non-gynecologic pathologists. Institutional Review Board approval was obtained from all institutions. Patients with a frozen section diagnosis of a benign process or invasive carcinoma but a final pathologic diagnosis of borderline ovarian tumor were excluded.

Study data were collected and managed using REDCap (Research Electronic Data Capture), a secure, web-based application designed to support data capture for research studies hosted at MD Anderson [10]. Descriptive statistics were calculated to summarize demographic (age, body mass index, race, ethnicity, tobacco use, medical history, gravidity/parity, family history, prior cancer diagnosis), clinical (imaging, tumor markers), and surgical characteristics of the patients at baseline and at surgery (approach, components of staging, frozen/final tumor diagnosis, stage, type of pathologist, tumor characteristics, treatment/follow-up). Intraoperative frozen section was considered accurate if final pathologic processing confirmed borderline ovarian tumor. Differences among the hospitals were tested for each demographic and clinical variable using appropriate statistical methodology. Multivariate logistic regression was performed to determine the association of frozen section accuracy by hospital type while adjusting for patient age. Contingency table analysis was

performed using Fisher's exact tests. Continuous variables were compared using Wilcoxon rank-sum tests and Kruskal-Wallis tests. Overall survival and recurrence-free survival were analyzed using the product limit estimator of Kaplan and Meier. Statistical analyses were performed using SAS 9.4 for Windows (SAS Institute Inc., Cary, NC). A p -value <0.05 was considered statistically significant with 95% confidence interval (CI) when appropriate.

RESULTS

Two hundred twelve patients were identified who had a frozen section diagnosis of borderline ovarian tumor at one of the four hospitals during the study period. Ninety-seven patients (46%) were diagnosed at the academic hospital with gynecologic pathologists (group 1), 70 (33%) were diagnosed at one of the two academic hospitals with non-gynecologic pathologists (group 2), and 45 (21%) were diagnosed at the community hospital with non-gynecologic pathologists (group 3). The three groups differed with respect to median age (55 years, 40 years, and 41 years in groups 1, 2 and 3, respectively) ($P < 0.0001$). Also, the percentages of patients with family and personal histories of cancer were higher in group 1 ($P < 0.0001$ for both comparisons) (Table 1).

On frozen section analysis, the most common diagnosis was serous borderline ovarian tumor (167 patients; 78.8%), followed by mucinous borderline ovarian tumor (39 patients; 18.5%) (Table 2). On final pathologic analysis, 154 patients (72.7%) had serous borderline ovarian tumors and 27 patients (12.7%) had mucinous borderline ovarian tumors (Table 3). Overall the frozen section diagnosis of borderline ovarian tumor correlated with the final pathologic diagnosis in 192 of 212 cases (90.6%). The accuracy of frozen section diagnosis did not differ by hospital type: for groups 1, 2, and 3, the frozen section diagnosis correlated with the final pathologic diagnosis in 91.8%, 90.0%, and 88.9% of cases, respectively ($P = 0.82$). After adjusting for age on multivariate analysis, hospital type did not impact accuracy of frozen section diagnosis. On final pathologic analysis, 7 patients (3.3%) had disease downgraded to benign neoplasm and 13 patients (6.1%) had disease upgraded to invasive carcinoma. Of these 13 patients, 7 (53.8%) had mucinous, 4 (30.8%) had serous, and 2 (15.4%) had endometrioid borderline ovarian tumor originally diagnosed on frozen section analysis. Ten of the 13 patients upgraded had apparent stage I disease. Mucinous borderline ovarian tumor ($P = 0.002$; odds ratio [OR] = 7.1; 95% CI, 2.1–23.7) and endometrioid borderline ovarian tumor ($P = 0.02$; OR = 32.4; 95% CI, 1.8–595.5) were more likely than serous borderline ovarian tumor to be upgraded to invasive carcinoma. Four patients (4.1%) in group 1, 6 patients (8.6%) in group 2, and 3 patients (6.7%) in group 3 had borderline ovarian tumor upgraded to invasive carcinoma ($P = 0.62$).

Of the 192 patients with borderline ovarian tumor confirmed on final pathologic analysis, 158 (82.3%) had stage I disease. The stage distribution did not differ between hospital types (Table 4). The final stage distribution by histology for the 192 pathologically confirmed borderline ovarian tumors is presented in Table 5. Seventeen patients (8.9%) had either positive washings or tumor rupture during surgery (stage IC). Thirty-seven patients (20.3%) had extra-ovarian disease (stage IIA). Of these 37 patients, 29 had noninvasive borderline ovarian tumor implants, five had invasive borderline ovarian tumor implants, and three had implants consistent with malignancy. Ascites was present in 17 patients of which 4 (23.5%)

and 13 (76.5%) had a diagnosis of mucinous or serous on final histology, respectively. Eight of these patients with serous histology had at least stage III borderline ovarian disease.

The frequency of surgical procedures for staging differed by hospital type and was divided into seven categories: cystectomy, unilateral salpingo-oophorectomy, bilateral salpingo-oophorectomy, peritoneal biopsy, omentectomy, appendectomy, and hysterectomy (Table 6). Patients treated at an academic hospital with gynecologic pathologists (group 1) were more likely to undergo a hysterectomy and have both ovaries removed than were patients treated at an academic hospital without gynecologic pathologists (group 2) or a community hospital without gynecologic pathologists (group 3). Patients in groups 2 and 3 were more likely than those in group 1 to undergo a cystectomy or unilateral oophorectomy preserving fertility and ovarian function. Lymph node sampling was performed in 88 patients (41.5%) and the frequency of such sampling did not differ by hospital type. Lymph node sampling revealed disease in 10 patients, all with serous histology. Nine patients had borderline ovarian tumor and one had invasive carcinoma in a lymph node. Of the 32 patients with a final pathologic diagnosis of mucinous borderline ovarian tumor, 24 (75%) had an appendectomy, and all samples were negative for disease.

With a median follow-up time of 57 months, six patients had a recurrence of borderline ovarian tumor (all with serous histology). All these patients underwent secondary resection and had no evidence of disease during the surveillance period. There were no deaths secondary to borderline ovarian tumor.

COMMENT

Our results with final pathologic diagnosis used as the gold standard demonstrate that a frozen section diagnosis of borderline ovarian tumor is highly likely to be accurate across a variety of hospital types. To our knowledge, this was the first study to compare the accuracy of frozen section diagnosis between academic and non-academic institutions and between gynecologic and non-gynecologic pathologists. The results of this study indicate that a frozen section diagnosis of borderline ovarian tumor is highly likely to be accurate independent of hospital setting or availability of subspecialized pathologists.

However, although most frozen section diagnoses of borderline ovarian tumor are accurate, we found that mucinous borderline ovarian tumors were more likely to be upgraded to invasive carcinoma than were endometrioid and serous borderline ovarian tumors. This phenomenon is well documented in the literature, which shows that mucinous borderline ovarian tumors are underdiagnosed more commonly than serous borderline ovarian tumors, because mucinous tumors tend to be larger and frequently contain benign, borderline, and malignant components that can be missed with sampling errors [12–14]. Providing adequate tissue samples from a larger tumor can help increase the sensitivity of detection of focal changes in borderline ovarian tumors [12,15]. Communicating to the pathologist relevant information, such as preoperative imaging findings, clinical information, tumor marker status, and intraoperative findings, can likely aid the pathologist in trying to arrive at the correct diagnosis on intraoperative frozen section analysis [14,11].

Given the significance of a frozen section diagnosis and the potential morbidities of surgical staging, strategies to help reduce surgical intervention in patients with borderline ovarian tumor have been an area of interest. In our study, practice patterns and extent of surgical staging varied by hospital type, but overall survival was not affected. Patients treated at an academic hospital with gynecologic pathologists (group 1) were more likely to undergo a hysterectomy and have both ovaries removed than were patients treated at an academic hospital without gynecologic pathologists (group 2) or a community hospital without gynecologic pathologists (group 3). Patients in groups 2 and 3 were more likely than those in group 1 to undergo a cystectomy or unilateral oophorectomy preserving fertility and ovarian function. However, in interpreting these results, differences in patient population among the three groups must be taken into account. The median age of patients in group 1 was 55 years, higher than the median age of patients in group 2 (40 years) and group 3 (41 years); age was not controlled for and this age difference likely partially explains the differences in surgical practices among institutions. In addition, patients in group 1 were more likely to have a personal or family history of cancer than were patients in groups 2 and 3, which may also have altered surgical management. Moreover, as groups 2 and 3 had more women of reproductive age and premenopausal women, fertility-sparing and ovarian-conserving management strategies were relevant for more patients in these groups [8,16].

Currently, the most important prognostic factors affecting survival and recurrence in patients with borderline ovarian tumors appear to be invasive implants (if associated with serous histology it is synonymous with low-grade serous carcinoma), the International Federation of Gynecology and Obstetrics stage, micropapillary pattern, and microinvasion [17]. At The University of Texas MD Anderson Cancer Center, after a frozen section diagnosis of borderline ovarian tumor, surgical staging includes pelvic washings, omental biopsy, thorough inspection of the peritoneal cavity and retroperitoneal structures with biopsy of any abnormal sites, palpation of the pelvic and aortic lymph nodes with removal of any abnormal nodes, and unilateral or bilateral salpingo-oophorectomy with or without hysterectomy depending on the patient's menopausal status and wishes regarding fertility preservation. A recent study by Matsuo et al showed no survival advantage from hysterectomy and lymphadenectomy in women with borderline ovarian tumor grossly limited to the ovaries [18]. Based on the findings presented here as well as previous studies, we recommend that complete surgical staging should be performed only after an extensive abdominal survey with a frozen section diagnosis of borderline ovarian tumor and if gross extra-ovarian disease is present.

It has been common practice for patients with mucinous borderline ovarian tumors to undergo an appendectomy as part of their surgical staging regardless of the appearance of the appendix. However, multiple studies have shown low utility of an appendectomy in detecting carcinoma in patients with a normal-appearing appendix [19–21]. In our study, all patients with a mucinous borderline ovarian tumor who underwent an appendectomy had normal findings on pathologic analysis of the appendix. However, although the literature has started to question the utility of appendectomy in mucinous borderline tumors, we continue to perform appendectomy, omental sampling, and peritoneal biopsies in all patients with a frozen section diagnosis of mucinous borderline tumor as that remains the standard of care

and, as in this study, those patients were the most likely to get upgraded to invasive carcinoma.

Limitations of our study include its retrospective nature and our inability to control for known and unknown confounders. For example, selection bias may be present in that patients who had more concern for malignancy (e.g., abnormal imaging, elevated tumor markers) may have been referred to a cancer center for surgery. The lack of recurrences and deaths precluded formal survival analysis as there were too few patients with follow-up beyond 5 years to permit any meaningful conclusions regarding long-term recurrence and survival. In addition, this study was performed in an urban setting where many pathologists may be acquainted with one another and share difficult cases with each other. It is unsure how our findings may be applicable to a more rural hospital. Although the Women's Hospital of Texas is a community medical center with non-fellowship trained pathologists, the experience there may not be representative of all community hospitals as based on their practice specialty. They do see a high volume of gynecologic pathology and therefore may have developed expertise not consistent with other community hospitals. Given that the years of experience and total number of frozen section diagnoses performed by each pathologist was not studied, this may impact the generalizability to other institutions. A strength of our study was the large number of patients with borderline ovarian tumors. This was the first study to compare the accuracy of frozen section diagnosis of borderline ovarian tumors across three different types of hospitals and between gynecologic pathologists and non-gynecologic pathologists.

In conclusion, frozen section diagnosis of borderline ovarian tumors is highly accurate regardless of the type of hospital and availability of subspecialized pathologists. Mucinous and endometrioid borderline ovarian tumors are more likely to be upgraded to an invasive carcinoma. Providers should understand the limitations of a frozen section diagnosis of such a tumor. Practice patterns and surgical staging may vary at different hospital settings but overall staging does not change outcomes. The surgeon should utilize the frozen section diagnosis and results of the intra-abdominal survey to decide what components of surgical staging to perform.

Acknowledgments

Supported by the NIH/NCI under award number P30CA016672

References

1. Taylor HC. Malignant and semimalignant tumors of the ovary. *Surg Gynecol Obs.* 1929; 48(2):204.
2. Karseladze AI. WHO histological classification of ovarian tumors. *Arkiv Patol.* 2005; (Suppl):1–64.
3. Skírnisdóttir I, Garmo H, Wilander E, Holmberg L. Borderline ovarian tumors in Sweden 1960–2005: trends in incidence and age at diagnosis compared to ovarian cancer. *Int J Cancer.* 2008; 123(8):1897–901. DOI: 10.1002/ijc.23724
4. Harter P, Gershenson D, Lhomme C, Lecuru F, Ledermann J, Provencher DM, ... Mahner S. Gynecologic Cancer InterGroup (GCIg) consensus review for ovarian tumors of low malignant potential (borderline ovarian tumors). *Int J Gynecol Cancer.* 2014; 24(9):S5–8. DOI: 10.1097/IGC.0000000000000282 [PubMed: 25341581]

5. Yazbek J, Raju KS, Ben- Nagi J, Holland T, Hillaby K, Jurkovic D. Accuracy of ultrasound subjective pattern recognition for the diagnosis of borderline ovarian tumors. *Ultrasound Obstet Gynecol.* 2007; 29(5):489–95. [PubMed: 17444554]
6. Medeiros LR, Rosa DD, Edelweiss MI, et al. Accuracy of frozen-section analysis in the diagnosis of ovarian tumors: A systematic quantitative review. *Int J Gynecol Cancer.* 2005; 15(2):192–202. DOI: 10.1111/j.1525-1438.2005.15203.x [PubMed: 15823099]
7. Shazly Sherif AM, Laughlin-Tommaso Shannon K, Dowdy Sean C, Famuyide Abimbola O. Staging for low malignant potential ovarian tumors: a global perspective. *Am J Obstet Gynecol.* 2016; 215(2):153–168. e2. DOI: 10.1016/j.ajog.2016.04.035 [PubMed: 27131584]
8. Houck K, Nikrui N, Duska L, Chang Y, Fuller AF, Bell D, Goodman A. Borderline tumors of the ovary: correlation of frozen and permanent histopathologic diagnosis. *Obstet Gynecol.* 2000; 95(6): 839–43. DOI: 10.1016/S0029-7844(99)00656-0 [PubMed: 10831977]
9. Trimble CL, Kosary C, Trimble EL. Long-term survival and patterns of care in women with ovarian tumors of low malignant potential. *Gynecol Oncol.* 2002; 86(1):34–7. DOI: 10.1006/gyno.2002.6711 [PubMed: 12079297]
10. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)--a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009; 42(2):377–81. DOI: 10.1016/j.jbi.2008.08.010 [PubMed: 18929686]
11. Ozgur, Bige; Ahmet, Demir; Ugur, Saygili; Funda, Gode; Turhan, Uslu; Meral, Koyuncuoglu. Frozen section diagnoses of 578 ovarian tumors made by pathologists with and without expertise on gynecologic pathology. *Gynecol Oncol.* 2011; 123(1):43–6. DOI: 10.1016/j.ygyno.2011.06.030 [PubMed: 21767870]
12. Tempfer Clemens B, Stephan Polterauer, Katrin Bentz Eva, Alexander Reinthaller, Hefler Lukas A. Accuracy of intraoperative frozen section analysis in borderline tumors of the ovary: A retrospective analysis of 96 cases and review of the literature. *Gynecol Oncol.* 2007; 107(2):248–52. DOI: 10.1016/j.ygyno.2007.06.008 [PubMed: 17631951]
13. Pinto PB, Andrade LA, Derchain SF. Accuracy of intraoperative frozen section diagnosis of ovarian tumors. *Gynecol Oncol.* 2001; 81(2):230–2. DOI: 10.1006/gyno.2001.6133 [PubMed: 11330954]
14. Sennur, Ilvan; Rana, Ramazanoglu; Elif, Ulker Akyildiz; Zerrin, Calay; Tugan, Bese; Nafi, Oruc. The accuracy of frozen section (intraoperative consultation) in the diagnosis of ovarian masses. *Gynecol Oncol.* 2005; 97(2):395–9. DOI: 10.1016/j.ygyno.2005.01.037 [PubMed: 15863135]
15. Salla, Kumpulainen; Tapio, Kuoppala; Arto, Leminen; , et al. Surgical staging, treatment, and follow-up of borderline tumors in different hospital categories: a prospective nationwide survey in Finland. *Acta Obstet Gynecol Scand.* 2007; 86(5):610–4. DOI: 10.1080/00016340701284707 [PubMed: 17464592]
16. Seong SJ, Kim DH, Kim MK, Song T. Controversies in borderline ovarian tumors. *J Gynecol Oncol.* 2015; 26(4):343–9. DOI: 10.3802/jgo.2015.26.4.343 [PubMed: 26404125]
17. Gershenson David M. Management of borderline ovarian tumours. *Best Pract Res Clin Obstet Gynaecol.* 2017; 41:49–59. DOI: 10.1016/j.bpobgyn.2016.09.012 [PubMed: 27780698]
18. Koji, Matsuo; Hiroko, Machida; Tsuyoshi, Takiuchi; , et al. Role of hysterectomy and lymphadenectomy in the management of early-stage borderline ovarian tumors. *Gynecol Oncol.* 2017; 144(3):496–502. DOI: 10.1016/j.ygyno.2017.01.019 [PubMed: 28131526]
19. Aoshuang, Cheng; Minghao, Li; Kanis Margaux, J; , et al. Is it necessary to perform routine appendectomy for mucinous ovarian neoplasms? A retrospective study and meta-analysis. *Gynecol Oncol.* 2016; 144(1):215–22. DOI: 10.1016/j.ygyno.2016.10.041 [PubMed: 27889016]
20. Kleppe M, Bruls J, Van Gorp T, et al. Mucinous borderline tumours of the ovary and the appendix: A retrospective study and overview of the literature. *Gynecol Oncol.* 2014; 133(2):155–8. DOI: 10.1016/j.ygyno.2014.02.013 [PubMed: 24552756]
21. Stefan, Cosyns; Philippe, De Sutter; Herman, Tournaye; Polyzos Nikolaos, P. Necessity of appendectomy for mucinous borderline ovarian tumors. Systematic review. *Arch Gynecol Obstet.* 2016; 294(6):1283–9. DOI: 10.1007/s00404-016-4174-y [PubMed: 27535756]

Table 1

Patient Characteristics Overall and by Hospital Type

Characteristic	Overall (n = 212)	Hospital Type			P Value
		Academic with Gynecologic Pathologists (n = 97)	Academic with Non-Gynecologic Pathologists (n = 70)	Community with Non-Gynecologic Pathologists (n = 45)	
Age (years), median (IQR)	48 (35–49)	55 (42–65)	40 (32–56)	41 (31–53)	<0.0001
BMI (kg/m ²), median (IQR)	29 (25–36)	28 (26–37)	30 (25–35)	26 (23–35)	0.10
Race					N/A
African American	17 (8.0)	5 (5.2)	9 (12.9)	3 (6.7)	
Asian/Pacific Islander	7 (3.3)	4 (4.1)	1 (1.4)	2 (4.4)	
Caucasian	140 (66.0)	79 (81.4)	22 (31.4)	39 (86.7)	
Native American	1 (0.5)	0 (0.0)	0 (0.0)	1 (2.2)	
Other	43 (20.3)	9 (9.3)	34 (48.6)	0 (0.0)	
Missing	4 (1.9)	0 (0.0)	4 (5.7)	0 (0.0)	
Ethnicity					<0.0001
Hispanic	59 (27.8)	18 (18.6)	35 (50.0)	6 (13.3)	
Non-Hispanic	147 (69.3)	79 (81.4)	29 (41.4)	39 (86.7)	
Missing	6 (2.8)	0 (0.0)	6 (8.6)	0 (0.0)	
Personal history of malignancy	43 (20.3)	33 (34.0)	5 (7.1)	5 (11.1)	<0.0001
Family history of malignancy	114 (53.8)	73 (75.3)	17 (24.3)	24 (53.3)	<0.0001

BMI, body mass index; IQR, interquartile range.

Data are n (%) unless otherwise specified.

Table 2

Frozen Section Overall and by Hospital Type

Frozen Section Diagnosis	Overall (n = 212)	Hospital Type			P Value
		Academic with Gynecologic Pathologists (n = 97)	Academic with Non-gynecologic Pathologists (n = 70)	Community with Non-gynecologic Pathologists (n = 45)	
Endometrioid	2 (0.9)	1 (1.0)	1 (1.4)	0 (0.0)	<0.0001
Mucinous	39 (18.5)	6 (6.2)	24 (34.3)	9 (20.0)	
Seromucinous	2 (0.9)	0 (0.0)	2 (2.9)	0 (0.0)	
Serous	167 (78.8)	90 (92.8)	41 (58.5)	36 (80.0)	
Other	2 (0.9)	0 (0.0)	2 (2.9)	0 (0.0)	

Data are n (%)

Table 3

Final Histology Overall and by Hospital Type

Final Histology	Overall (n = 212)	Hospital Type			P Value
		Academic with Gynecologic Pathologists (n = 97)	Academic with Non-gynecologic Pathologists (n = 70)	Community with Non-gynecologic Pathologists (n = 45)	
Invasive carcinoma	13 (6.1)	4 (4.1)	6 (8.6)	3 (6.7)	0.002
Benign neoplasm	7 (3.3)	4 (4.1)	1 (1.4)	2 (4.4)	
Mixed	11 (5.2)	6 (6.2)	4 (5.7)	1 (2.2)	
Mucinous	27 (12.7)	3 (3.1)	17 (24.3)	7 (15.6)	
Serous	154 (72.7)	80 (82.5)	42 (60.0)	32 (71.1)	

Data are n (%)

Table 4

Disease Stage by Hospital Type

Stage	Overall (n = 192)	Hospital Type			P Value
		Academic with Gynecologic Pathologists (n = 89)	Academic with Non-gynecologic Pathologists (n = 63)	Community with Non-gynecologic Pathologists (n = 40)	
I	158 (82.3)	69 (77.5)	55 (87.3)	34 (85.0)	0.38
II	7 (3.6)	3 (3.4)	3 (4.8)	1 (2.5)	
III	27 (14.1)	17 (19.1)	5 (7.9)	5 (12.5)	

Data are n (%).

Table 5

Disease Stage by Final Pathology

Stage	Histology				P Value
	Overall (n = 192)	Serous (n = 154)	Mucinous (n = 27)	Mixed (n = 11)	
Substage					0.68
IA	127 (66.1)	94 (61.0)	24 (88.9)	9 (81.8)	
IB	14 (7.3)	13 (8.4)	0 (0.0)	1 (9.1)	
IC	17 (8.9)	13 (8.4)	3 (11.1)	1 (9.1)	
IIA	2 (1.0)	2 (1.3)	0 (0.0)	0 (0.0)	
IIB	3 (1.6)	3 (1.9)	0 (0.0)	0 (0.0)	
IIC	2 (1.0)	2 (1.3)	0 (0.0)	0 (0.0)	
IIIA	10 (5.2)	10 (6.5)	0 (0.0)	0 (0.0)	
IIIB	4 (2.1)	4 (2.6)	0 (0.0)	0 (0.0)	
IIIC	13 (6.8)	13 (8.4)	0 (0.0)	0 (0.0)	
Stage					0.03
I	158 (82.3)	120 (77.9)	27 (100)	11 (100)	
II	7 (3.6)	7 (4.5)	0 (0.0)	0 (0.0)	
III	27 (14.1)	27 (17.5)	0 (0.0)	0 (0.0)	

Data are n (%).

Table 6

Staging Practice Patterns Overall and by Hospital Type

Practice	Overall (n = 212)	Hospital Type			P Value
		Academic with Gynecologic Pathologists (n = 97)	Academic with Non-gynecologic Pathologists (n = 70)	Community with Non-gynecologic Pathologists (n = 45)	
Intraoperative washings	199 (93.9)	94 (96.9)	63 (90.0)	42 (93.3)	0.56
Hysterectomy	122 (57.5)	66 (68.0)	36 (51.4)	20 (44.4)	0.01
Cystectomy	26 (12.3)	6 (6.2)	12 (17.1)	8 (17.8)	0.03
USO	54 (25.5)	17 (17.5)	24 (34.3)	13 (28.9)	0.04
BSO	147 (69.3)	78 (80.4)	42 (60.0)	27 (60.0)	0.005
Omentectomy	177 (83.5)	87 (89.7)	64 (91.4)	26 (57.8)	<0.0001
Appendectomy	53 (25.0)	10 (10.3)	37 (52.9)	6 (13.3)	<0.0001
Peritoneal biopsy	157 (74.1)	78 (80.4)	53 (75.7)	26 (57.8)	0.02
Lymph node sampling	88 (41.5)	39 (40.2)	33 (47.1)	16 (35.6)	0.43

BSO, bilateral salpingo-oophorectomy; USO, unilateral salpingo-oophorectomy.

Data are n (%).