



## Original Research Article

## Diagnostic accuracy of intraoperative frozen section in ovarian surface epithelial tumors: A retrospective correlation with final histopathology

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### Abstract

**Background:** Intraoperative frozen section (FS) diagnosis is a critical diagnostic tool in the treatment of ovarian surface epithelial tumors that informs the surgical team and guides surgical procedure by giving information about the type of tumor specifically differentiating benign, borderline and malignant nature. This research seeks to assess the diagnostic efficacy of FS in ovarian surface epithelial tumors by comparing it with final histopathology.

**Materials and Methods:** A five-year retrospective study (from January 2020 to December 2024) was performed at a tertiary care teaching hospital. A total of 150 patients undergoing intraoperative FS examination for ovarian surface epithelial tumors were enrolled. FS diagnoses were divided into benign, borderline, or malignant and correlated with final paraffin section histopathology. Performance of the diagnostic test was compared on the basis of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy.

**Results:** In 150 cases, FS and final histopathology were concordant in 135 (90%) cases. FS was correct in diagnosing 92 of 95 benign tumors, 15 of 25 borderline tumors, and 28 of 30 malignant tumors. Sensitivity and specificity were highest for malignant tumors (97.7% and 93.3%, respectively) and lowest for borderline tumors (60.0% and 94.1%, respectively). The most frequent discordance was with mucinous borderline tumors and large lesions (>10 cm) due to sampling constraints.

**Conclusion:** FS is a very sensitive and accurate intraoperative diagnostic tool for ovarian tumors, especially benign and malignant lesions. Nevertheless, caution is exercised in borderline tumors because of decreased sensitivity, requiring careful sampling and interpretation.

**Keywords:** Ovarian tumors, Frozen section, Histopathology, Diagnostic accuracy, Borderline tumors, Intraoperative diagnosis.

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### 1. Introduction

Ovarian neoplasms encompass a broad range of tumors including benign, borderline, and malignant epithelial neoplasms, each necessitating individualized therapeutic management. Intraoperative diagnosis is critical in planning surgical therapy, particularly in situations where the preservation of fertility or adequacy of surgical extirpation is to be modulated to the type of lesion. For these situations, intraoperative frozen section (FS) analysis has been a useful diagnostic modality for intraoperative diagnosis of ovarian neoplasms. Frozen section enables an instantaneous histologic diagnosis and thus enables surgeons to take the appropriate intraoperative decisions, particularly in the distinction of benign, borderline, and malignant tumors. The utility of FS is not only in its expediency but also in avoiding

unnecessary extensive surgery or under-treatment, particularly in young women where preservation of fertility is of the highest priority (Kumar et al., 2021; Hashmi et al., 2016).<sup>1,2</sup> Although helpful, the reliability of FS may be compromised by several factors including the tumor type, size, heterogeneity, and the experience of the pathologist (Wasington et al., 2008; Ilvan et al., 2005).<sup>3,5</sup>

A number of studies have evaluated the accuracy of frozen section diagnosis of ovarian tumors, with generally high sensitivity and specificity for benign and malignant tumors. Accuracy is, however, reduced for borderline tumors due to their complex histopathological characteristics and overlapping characteristics with benign and malignant neoplasms (Morton et al., 2017; Yarandi et al., 2008).<sup>6,8</sup> Abudukadeer et al. (2016)<sup>4</sup> indicated that frozen section

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analysis has sensitivity rates of more than 90% for benign and malignant tumors but drops to around 65–75% for borderline tumors. A systematic review by Ratnavelu et al. (2016)<sup>7</sup> also noted heterogeneity of FS accuracy by tumor type, with the implication being that although FS is still a sound tool in the majority of situations, care must be taken, especially in mucinous or borderline histology. Likewise, research in other geographic locations, such as Asian and European environments, has shown similar diagnostic performance, noting the applicability of frozen section analysis across various clinical situations (Hashmi et al., 2016; Abudukadeer et al., 2016; Ilvan et al., 2005).<sup>2,4,5</sup>

Since intraoperative decision-making impacts the outcome of the patient and the proven limitations of FS with certain histological subtypes, ongoing evaluation of its performance as a diagnostic method is justified. The present retrospective study aims to identify intraoperative frozen section diagnostic accuracy in ovarian surface epithelial tumors within our institution and to compare them to the final histopathological results. This will enable us to contribute to the present evidence and perhaps inform optimization of intraoperative consultation practices.

## 2. Materials and Methods

### 2.1. Research background and design

This is a retrospective, observational study in the Department of Pathology with the assistance of the Department of Obstetrics and Gynecology of a tertiary care teaching hospital. The study was conducted for more than five years, from January 2020 to December 2024. Institutional ethical committee clearance was obtained before the study was started, and patient data were anonymized to ensure confidentiality.

### 2.2. Study population

The study encompassed all the female patients who underwent surgical removal of ovarian masses and intraoperative FS study during the aforementioned study period. Patients in whom no FS was done or final diagnosis of any tumor other than surface epithelial were excluded from the study. A total of 200 cases were identified, 150 of which were included based on the study criteria and were examined.

### 2.3. Data acquisition

Relevant clinical information, such as patient age, clinical presentation, imaging results, and intraoperative results, was obtained from patient records. Intraoperative frozen section and respective final paraffin-embedded permanent section histopathological results were examined. Frozen section diagnosis was compared with definitive histopathological diagnosis, which provided the gold standard for the accuracy of diagnosis to be measured against.

Intraoperative specimens that were representative of the resected ovarian masses were sent fresh to the pathology

laboratory. After initial gross observation, representative areas sectioned and tissue sections were frozen immediately in a cryostat at  $-20^{\circ}\text{C}$ , sectioned at 5  $\mu\text{m}$  thickness, stained with hematoxylin and eosin, and assessed by a senior surgical pathologist. Diagnosis of tumor type done and surface epithelial tumors were provisionally graded as benign, borderline, or malignant based on standard histological criteria. The remaining specimen was fixed in 10% formalin, processed by standard methods, and examined on permanent paraffin sections.

### 2.4. Analysis

Data were processed and tabulated using SPSS software version 25.0. The precision of frozen section diagnosis was quantified by estimating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy for each tumor category—benign, borderline, and malignant. Rates of concordance and discordance between final histopathological diagnoses and frozen sections were estimated. Additionally, the causes of differences in diagnoses were examined on the basis of tumor subtype, size, and sampling limitation issues.

## 3. Results

A total of 150 patients who had intraoperative frozen section (FS) analysis of ovarian surface epithelial tumors were included. The patient's age varied from 17 to 75 years with a mean of 46.2 years. The symptoms at presentation were lower abdominal pain in 62%, distension in 24%, and menstrual irregularities in 14%. Of the cases, 95 (63.3%) were benign, 25 (16.7%) were borderline, and 30 (20%) were malignant on final histopathology.

### 3.1. Correlation between frozen section and final histopathology

Of the 150 cases, intraoperative frozen section diagnosis completely agreed with the final histopathological diagnosis in 135 cases (90%). Disagreement in diagnoses occurred in 15 cases (10%). The frozen section correctly diagnosed 92 of 95 benign tumors, 15 of 25 borderline tumors, and 28 of 30 malignant tumors.

**Table 1** presents the distribution of diagnoses across benign, borderline, and malignant categories as determined by frozen section and final permanent histology.

**Table 1:** Correlation of frozen section diagnosis with final histopathology

Final Diagnosis	FS Diagnosis: Benign	FS Diagnosis: Borderline	FS Diagnosis: Malignant	Total
Benign	92	2	1	95
Borderline	6	15	4	25
Malignant	1	1	28	30
Total	99	18	33	150

3.2. Diagnostic accuracy of frozen section

Frozen section diagnostic performance varied depending on the tumor type. Sensitivity and specificity of benign tumors were 95.7% and 96.8%, respectively. The sensitivity was 97.7% and specificity was 93.3% for malignant tumors. Borderline tumors, nonetheless, had decreased sensitivity of 60% and specificity of 94.1%. Overall, the diagnostic accuracy of FS was 90%.

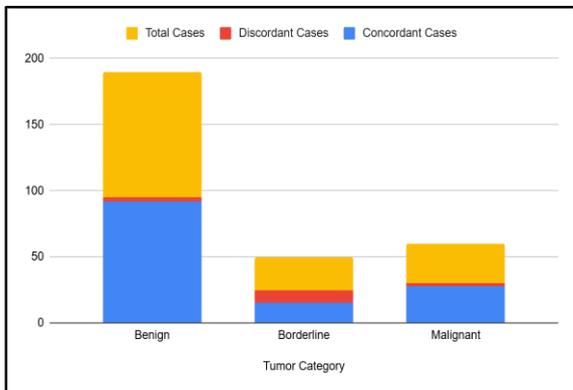
Table 2 summarizes sensitivity, specificity, PPV, NPV, and overall accuracy for each category of ovarian tumor.

Table 2: Diagnostic performance of frozen section by tumor category

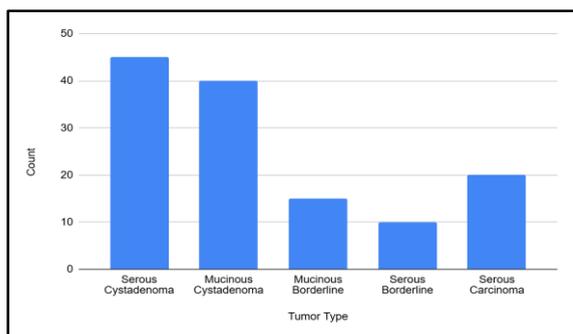
Category	Sensitivity (%)	Specificity (%)	PPV (%)
Benign	96.8	95.7	92.9
Borderline	60.0	94.1	83.3
Malignant	93.3	97.7	84.8

3.3. Diagnostic discordance and tumor subtypes

The greatest discordance rate occurred with mucinous borderline tumors, commonly misclassified as benign or malignant on FS secondary to sampling error and histologic heterogeneity. Tumors of a greater size (>10 cm) also caused difficulty in diagnosis owing to intraoperative limited sampling.



Graph 1: Concordance rates of frozen section diagnosis with final histopathology



Graph 2: Distribution of common histologic subtypes among ovarian tumors

Graph 1 illustrates the percentage of concordant and discordant cases in each diagnostic category (benign, borderline, malignant). The graph emphasizes the highest concordance in benign tumors and the lowest in borderline tumors.

Graph 2 showing the distribution of common histological subtypes including serous cystadenoma, mucinous cystadenoma, serous carcinoma, mucinous borderline tumor, and endometrioid carcinoma. Serous cystadenoma was the most frequent benign tumor, while serous carcinoma predominated among malignancies. Rest of the cases were of clear cell carcinoma and brenner tumors.

3.4. Concordant cases (Figure 1-3)

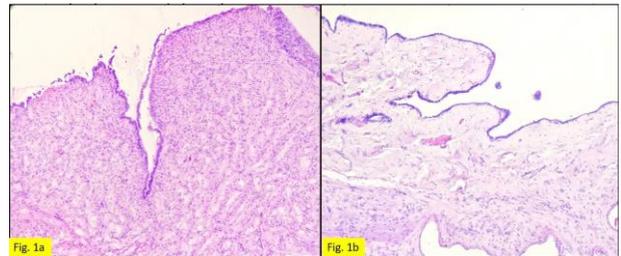


Figure 1: a: Serous cystadenoma (Frozen); b: Serous cystadenoma (H&E)

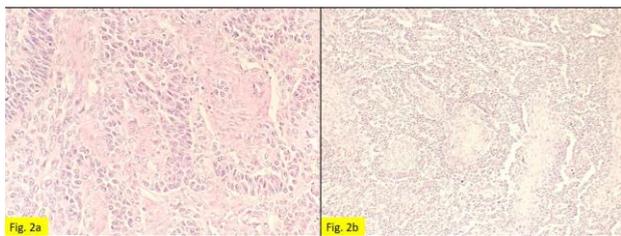


Figure 2: a: Brenner (frozen); b: Brenner (H&E)(b)

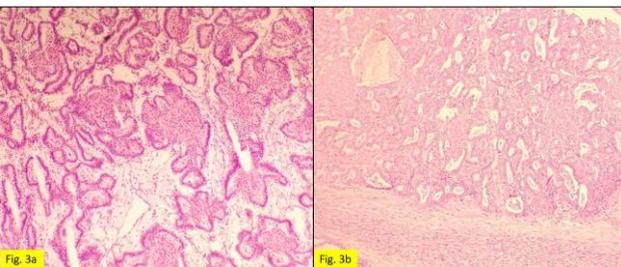


Figure 3: a: Clear cell carcinoma (Frozen); b: Clear cell carcinoma (H&E)

3.5. Discordant cases (Figure 4,5)

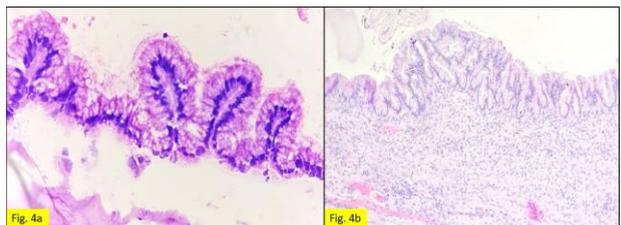
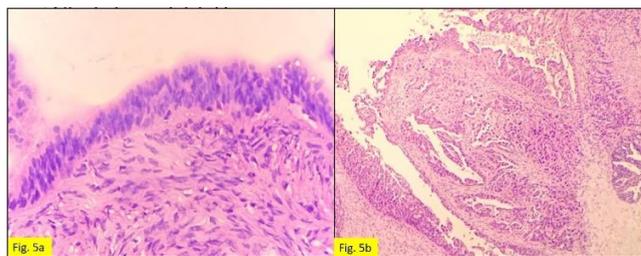


Figure 4: a: Borderline Mucinous (Frozen); b: Mucinous cystadenoma (H&E)



**Figure 5: a:** Borderline Serous (Frozen); **b:** Serous cyst adenocarcinoma (H&E)

#### 4. Discussion

Intraoperative frozen section (FS) is an essential diagnostic procedure in the management of ovarian neoplasms to guide the extent of surgical procedure and avoid unwarranted staging operations. In this series of 150 cases, FS had a global diagnostic accuracy of 90%, which was seen to vary by sensitivity and specificity according to the category of benign, borderline, or malignant tumors. These observations confirm the continued usefulness of FS in the clinical practice of gynecologic oncology, although its limitations are best exemplified in the diagnosis of borderline tumors.

In the current study, frozen section (FS) diagnosis results were found to have complete concordance with final histopathological results in 135 out of 150 cases (90%), which is close to earlier reported studies. For benign neoplasms, FS had excellent diagnostic accuracy, with sensitivity of 95.7% and specificity of 96.8%. Similarly, malignant neoplasms also had excellent performance for FS, with sensitivity of 97.7% and specificity of 93.3%. These findings are consistent with the study of Subbian et al. (2013),<sup>9</sup> which reported FS accuracy rates of 92.4% for benign tumors and 91.1% for malignant tumors at a regional cancer center in India, further confirming the efficacy of FS in these groups.

However, the strongest obstacle remains intraoperative diagnosis of borderline tumors with precision. In the present study, borderline tumors had a lower sensitivity of 60%, although a specificity of 94.1% was obtained; this discrepancy is usually attributed to histological heterogeneity and sampling problems. This problem is typically reported in the literature. Wootipoom et al. (2006) hypothesized a similar problem, citing frozen section analysis often misdiagnosing mucinous borderline tumors because of the complex architecture and requirement for extensive tissue sampling, which may not be feasible during surgery.<sup>10</sup> Similarly, Muruthapongsatorn et al. (2019) reported borderline tumor sensitivity of 63.4%, illustrating the continued poor performance of frozen section analysis in this group across different populations and healthcare settings.<sup>11</sup>

The accuracy of frozen section diagnosis in malignancies was very high in our study, accurately diagnosing 28 out of 30 malignant cases. The finding is consistent with the study of Bajracharya Shakya et al. (2018), who established a

diagnostic concordance rate of 89% for malignant tumors in their study at a tertiary oncology center.<sup>12</sup> Likewise, Rose et al. (1994) also reported that FS attained a rate of more than 90% accuracy in the discrimination of malignant tumors from benign or borderline tumors, a finding that is crucial for timely surgical decision-making in oncological operations.<sup>13</sup>

Notably, Açıkalın et al. (2014) also reported the diagnostic performance of FS in ovarian surface epithelial tumors at 91.7%, which is highly consistent with our results. They highlighted that the size of the tumor, particularly in mucinous tumors greater than 10 cm, was a major diagnostic problem owing to sampling errors—a finding in our study, in which discordant cases were more common in larger mucinous tumors.<sup>14</sup>

Suprasert et al. (2008) also emphasized the importance of frozen section (FS) in a poor-resource setting, with a mean rate of accuracy of 88.2%. Their study emphasizes the role of FS as a productive tool, even in hospitals lacking advanced frozen section facilities, provided that there is faculty pathology support and familiarity with tumor-related issues.<sup>15</sup> Together, our investigation validates the ongoing role of intraoperative FS in the diagnosis and surgical treatment of ovarian tumors. Although it continues to be extremely reliable in diagnosing benign and malignant lesions, it should be used with caution in interpreting FS results in borderline tumors, especially mucinous histology. Multidisciplinary planning between the surgical and pathological teams is needed to avoid sampling error and maximize diagnostic yield. Our results, in accordance with several international and regional series, validate the utility of FS as an effective and useful intraoperative tool, but with acknowledged limitations in specific histologic subtypes.

#### 5. Conclusion

In conclusion, the intraoperative frozen section is a highly valuable diagnostic tool in the evaluation of ovarian tumors, demonstrating excellent accuracy for benign and malignant lesions, with an overall diagnostic concordance rate of 90% in this study. Its reliability facilitates appropriate intraoperative decision-making and helps tailor surgical management effectively. However, its diagnostic performance is notably lower for borderline tumors, particularly of mucinous subtype, due to inherent histologic heterogeneity and limitations in sampling during surgery. Despite these challenges, the findings reinforce that, when interpreted cautiously and in conjunction with clinical and radiologic data, frozen section remains an indispensable component in the intraoperative assessment of ovarian neoplasms.

#### 6. Conflict of Interest

None.

## 7. Source of Funding

None.

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