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Original Research Article

DIAGNOSTIC UTILITY OF FROZEN SECTION BIOPSY IN EVALUATING OVARIAN TUMORS

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ABSTRACT

Background: Frozen section biopsy is a rapid technique implemented in the intraoperative setting, utilized in the diagnosis of ovarian neoplasms. It helps in the early differentiation of benign, borderline, and malignant lesions, as well as when to preserve fertility or whether to stage further. Despite its high accuracy in diagnosing benign and malignant lesions, its reliability decreases in borderline lesions because of histological heterogeneity. The current study aimed to evaluate the diagnostic accuracy and limitations of frozen section biopsy in the diagnosis of various ovarian tumors.

Materials and Methods: All patients undergoing surgery for clinically and radiologically diagnosed ovarian masses and who consented to intraoperative frozen section examination were included. The study population comprised women of all age groups presenting with ovarian tumors scheduled for surgical intervention in our hospital.

Results: In this study involving 45 patients undergoing frozen section (FS) analysis for ovarian tumors, the majority were aged 30–50 years, with 62.2% of tumors measuring less than 10 cm and 80% being unilateral. FS diagnoses showed high concordance with final histopathology, especially for benign (90%) and malignant (88.9%) tumors, yielding an overall diagnostic accuracy of 86.7%. Borderline tumors demonstrated lower sensitivity (57.1%). Discrepancies in six cases were attributed to sampling errors, interpretational challenges, and technical artifacts. Diagnostic accuracy was slightly higher in tumors ≥10 cm (88.2%) compared to those <10 cm (85.7%), indicating consistent frozen section performance.

Conclusion: This study found that frozen section is a valuable tool for intraoperative evaluation of ovarian tumors with high accuracy for benign and malignant lesions. However, its limited sensitivity for benign ovarian tumors should be kept in mind before interpretation, and final histopathological diagnosis must be confirmed in such cases.

Keywords: Frozen Section, Ovarian Tumors, Histopathology, Accuracy.

INTRODUCTION

Ovarian tumors present various neoplasms of distinct histological origins that demonstrate different clinical behaviors, which affect treatment options. The accurate diagnosis of ovarian tumors during surgery remains essential for surgeons to make proper treatment decisions between benign and malignant or borderline conditions. Frozen section biopsy functions as a vital tool for guiding surgical decisions immediately after surgery while minimizing unnecessary procedures, among reproductive-aged women and patients with other comorbidities that may not preclude radical interventions. The incidence of ovarian tumors shows global variations, and the most common ovarian tumors are epithelial ovarian tumors, accounting for about 90% of all diagnosed ovarian malignancies. Although there are several advances in imaging modalities for diagnosis, and there is also availability of tumor markers such as CA-125, preoperative diagnosis remains elusive due to the presence of overlapping features among benign, borderline, and malignant lesions.[1] Therefore, intraoperative frozen section examination becomes crucial with its ability of rapid histological

evaluation, which will enable surgical management according to the histopathological nature of the lesion. Generally, frozen section involves the rapid freezing of fresh tissue specimens followed by sectioning using a cryostat and staining for microscopic analysis. A provisional diagnosis can be arrived at as early as 15 – 20 minutes, which significantly influences the decision of the extent of surgery to be done in that particular case and to perform fertility-sparing surgery.[2] The frozen section is particularly very important in distinguishing benign lesions from malignant ovarian tumors, which require a different surgical approach. Since benign diagnosis requires a conservative surgery where whereas a malignant diagnosis will require a radical approach based on the staging and cytoreduction.[3] Various studies in this field have shown that the sensitivity and specificity of frozen section diagnosis of ovarian tumors have found accuracies ranging from 86% to 97% for benign and malignant tumors, and lower accuracy (60–80%) was observed in the case of borderline tumors because of their heterogenicity.[4] Therefore, Borderline ovarian tumors (BOTs) present a significant diagnostic challenge, which may exhibit focal areas of epithelial proliferation without stromal invasion that could be underrepresented in frozen section sampling [5]. As a result, multiple sampling and experienced pathologists are required for diagnostic precision. Despite being an important tool for diagnosis, frozen section has its limitations, which could be due to tissue artifacts during freezing, small sample size obtained, and the complexity of ovarian tumor histology, which determines accuracy. It has been found that certain tumor subtypes, such as mucinous and borderline tumors, show a higher rate of diagnostic discrepancy compared to final paraffin sections.[6] However, when combined with clinical and radiological findings, frozen section significantly contributes to intraoperative decision-making and reduces the frequency of second surgeries.[7] Recently, there has been emphasis on optimizing frozen section results by application of standard protocols and sampling techniques. There is a requirement for multidisciplinary collaboration between surgeons and pathologists for improving intraoperative diagnostic outcomes. With increased training and standardization, frozen section continues to be a cornerstone in the intraoperative assessment of ovarian tumors. The current study was designed to evaluate the diagnostic accuracy, sensitivity, and specificity of frozen section biopsy in differentiating benign, borderline, and malignant ovarian tumors.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Pathology in collaboration with the Department of Obstetrics and Gynecology at Mahavir Institute of Medical Sciences, Vikarabad, Telangana. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study.

All patients undergoing surgery for clinically and radiologically diagnosed ovarian masses and who consented to intraoperative frozen section examination were included. The study population comprised women of all age groups presenting with ovarian tumors scheduled for surgical intervention.

Inclusion Criteria

1. Patients with ovarian masses detected on imaging.
2. Patients who underwent intraoperative frozen section biopsy.
3. Patients who provided informed consent.

Exclusion Criteria

1. Patients with non-ovarian pelvic masses.
2. Inadequate tissue sample for frozen section processing.
3. Previously diagnosed or treated cases of ovarian carcinoma.

A total of n=50 patients with ovarian tumors were included based on consecutive sampling during the study period.

Procedure

During laparotomy or laparoscopy, suspected ovarian tumors were surgically excised and sent for intraoperative frozen section evaluation. A representative portion of the tumor was rapidly frozen using a cryostat at -20°C to -30°C. Thin sections (4–6 µm) were cut, stained with Hematoxylin and Eosin (H&E), and examined by an experienced pathologist. The frozen section diagnosis was then communicated intraoperatively to the surgical team to guide decisions regarding the extent of surgery, whether conservative or radical. The remaining specimen was processed routinely for paraffin-embedded histopathology, and the final diagnosis was established after thorough examination.

Data Collection

The frozen section diagnosis and the corresponding final histopathological diagnosis were recorded. Clinical data, including patient age, tumor size, laterality, radiological findings, and intraoperative impression, were also collected.

The frozen section diagnosis was categorized as:

- Benign
- Borderline
- Malignant

These were compared with the final histopathological results to evaluate the accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of frozen section in diagnosing ovarian tumors.

Statistical Analysis: Data were entered and analyzed using SPSS version 23. Categorical variables were expressed as percentages. Diagnostic parameters such as sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy were calculated. P-

values <0.05 were considered statistically significant where applicable.

RESULTS

Table 1 shows the demographic profile of the cases included in the study. A total of N=45 patients underwent frozen section analysis for tumors. The majority were aged 30–50 years (55.6%), with a smaller portion under n=30 (17.8%) or over n=50 (26.7%). Most tumors were under 10cm (62.2%) and unilateral (80%). Radiological analysis showed 71.1% were benign, while 28.9% were suspected as borderline or malignant

Table 1: Demographic and Clinical Characteristics of Patients (n=45)

Parameter	Number (0%)
Age (years)	
< 30	8 (17.8%)
30-50	25 (55.6%)
> 50	12 (26.7%)
Tumor Size	
< 10 cm	28 (62.2%)
210 cm	17 (37.8%)
Laterality Unilateral	36 (80.0%)
Bilateral Radiological Impression	9 (20.0%)
Benign	32 (71.1%)
Borderline/Malignant	13 (28.9%)

Table 2 shows the comparison of frozen section analysis and the final histopathological diagnosis in the cases of the study. We found that in 30 cases initially diagnosed as benign on FS, n=27 cases were confirmed histopathologically, while n=3 cases were misclassified (2 borderline, 1 malignant). Of the n=6 frozen section borderline cases, n=4 cases were confirmed, but one was benign and one malignant. All n=9 malignant FS cases showed strong agreement, with n=8 confirmed and only one downgraded. This demonstrates high concordance overall, particularly for malignant and benign categories, with borderline lesions showing more diagnostic variability.

Table 2: Comparison of Frozen Section (FS) and Final Histopathology Diagnoses

Frozen Section	Final Diagnosis			Total
	Benign	Borderline	Malignant	
Benign	27	2	1	30
Borderline	1	4	1	6
Malignant	0	1	8	9
Total	28	7	10	45

Table 3 depicts the details of the diagnostic accuracy of FS across benign, borderline, and malignant tumor categories. A critical analysis of the table showed that frozen section showed high sensitivity (96.4%) and specificity (94.1%) for benign lesions, with a strong negative predictive value (NPV) at 97.1%. For malignant lesions, sensitivity was 80%, specificity was 97.1%, and NPV was 94.6%; borderline lesions showed the lowest sensitivity (57.1%) but relatively high specificity (92.1%). Overall diagnostic accuracy was 86.7%, indicating that frozen section is a reliable diagnostic tool for benign and malignant tumors. Although its performance is limited in accurately classifying borderline tumors.

Table 3: Diagnostic Performance of Frozen Section Biopsy

Metric	Benign	Borderline	Malignant	Overall
Sensitivity	96.40%	57.10%	80.00%	86.70%
Specificity	94.10%	92.10%	97.10%	93.30%
PPV	90.00%	66.70%	88.90%	-
NPV	97.10%	89.70%	94.60%	-
Accuracy	-	-	-	86.70%

Table 4 analyzes the n=6 cases where frozen section diagnosis did not match the final histopathology results. In n=3 cases, benign frozen section diagnoses were upgraded to borderline or malignant due to sampling errors or technical issues of freezing delays. N=2 borderline frozen section cases were different, one being benign and the other malignant due to challenges in interpretation or missed focal malignancy. N=1 malignant frozen section case was downgraded to borderline, likely due to overinterpretation of cellular atypia. These discrepancies show the key limitations of frozen section, particularly related to sample heterogeneity and interpretative variability.

Table 4: Analysis of Discrepant Cases (n=6)

FS Diagnosis	Final Diagnosis	Number	Probable Reason
Benign	Borderline	2	Sampling error (heterogeneous tumor)
Benign	Malignant	1	Technical artifact (freezing delay)
Borderline	Benign	1	Interpretational challenge
Borderline	Malignant	1	Focal malignant features missed
Malignant	Borderline	1	Overinterpretation of atypia

Table 6 evaluates the influence of tumor size on frozen section diagnostic accuracy. In tumors < 10 cm (n=28), n=24 cases were in concurrence, yielding an accuracy of 85.7%. For tumors ≥ 10 cm (n=17), n=15 cases were concurrence, with a slightly higher accuracy of 88.2%. These findings suggest that frozen performs consistently well across tumor sizes, with slightly improved accuracy in larger lesions. However, the marginal difference shows that factors other than size, such as tumor heterogeneity or location, may play a more significant role in diagnostic precision.

Table 5: Diagnostic Accuracy by Tumor Size

Tumor Size	Concordant Diagnoses	Discordant Diagnoses	Accuracy
< IO cm (n=28)	24	4	85.70%
≥10 cm (n=17)	15	2	88.20%

DISCUSSION

The present study was done to evaluate the diagnostic utility of intraoperative frozen section analysis in the assessment of ovarian tumors. We evaluated its accuracy across benign, borderline, and malignant categories with histopathology. The results of this study show that frozen section is a highly reliable tool for distinguishing benign and malignant ovarian neoplasms. The overall diagnostic accuracy was 86.7%. However, the performance of frozen section in accurately classifying borderline tumors remains low, which remains a challenge as noted in the literature. [8, 9] In this study, we included a sample from a cohort of 45 cases, frozen section FS demonstrated high sensitivity (96.4%) and specificity (94.1%) for benign tumors. The results for malignant tumors were also very good, with (sensitivity of 80.0% and, specificity of 97.1%. These values are in agreement with the prior studies done in this field, which show that frozen section sensitivity for benign tumors ranges from 99%, and for malignant tumors from 87% to 99%.[10] We also found a high negative predictive value for benign (97.1%) and malignant (94.6%) tumors, further underscoring frozen section's utility in intraoperative decision-making. Although we found that the frozen section sensitivity is limited in cases of borderline tumors (57.1%), with a relatively high specificity (92.1%). This diagnostic limitation has been reported in several other studies in this field, highlighting the inherent challenges in accurately identifying borderline ovarian tumors.[6] The main cause of difficulty is because histopathological complexity of borderline tumors, particularly mucinous subtypes, which often contain areas of benign, borderline, and malignant histology within the same lesion.[11]

Our analysis of (n=6) discrepant cases in this study showed that there were sampling errors and interpretational challenges that contributed to the misclassification. More specifically (n=2), benign frozen section diagnoses were upgraded to borderline on final histopathology due to error in sampling, and one of the benign frozen section diagnoses was upgraded to malignant due to technical artifacts because of freezing delay. These results are in concordance with previous studies, where they reported that under-sampling and technical limitations during FS processing can lead to diagnostic inaccuracies.[12] The analysis of tumor size as a potential factor for influencing frozen section accuracy showed that accuracy rates for tumors <10 cm were 85.7% and ≥10 cm were 88.2%, suggesting that size alone may not significantly impact diagnostic concordance. In contrast, other studies have indicated that larger tumor size, particularly mucinous tumors, may increase the likelihood of sampling error due to greater histological heterogeneity. [8,13,14] Therefore, size alone may not directly affect the frozen section accuracy; it can contribute to diagnostic challenge indirectly by presenting a complicated tissue architecture. There are important clinical consequences involved in the magnitude of accuracy that frozen section diagnosis can achieve in ovarian tumors. Failure to do so can lead to overtreatment in some, if not most, benign cases. Under staging in all, if not most, malignant cases. However, some disadvantages that are associated with the diagnosis of benign ovarian tumors should be noted as well. The treatment plan relies heavily on the findings of FS, where in cases where FS provides a suspicion of a borderline tumor, particularly in young females desiring fertility, the surgeon may proceed with a conservative surgery with the understanding that the final histopathology may require further surgery. This approach emphasizes the need for interdisciplinary management of ovarian tumors, as well as effective counseling of the patients. There are important implications of frozen section diagnostic accuracy, which are clinically important. An accurate intraoperative diagnosis can enable the surgical team to manage appropriately. This could potentially avoid overtreatment in benign cases and

also ensure comprehensive treatment in malignant cases. However, the limitations in diagnosing benign ovarian tumors should be considered cautiously. In cases where frozen section suggests borderline tumor in younger cases who desire fertility preservation, surgeons could opt for a conservative approach, although final pathology may require further intervention. This shows the importance of multidisciplinary collaboration and patient counselling in the management of ovarian tumors.

CONCLUSION

Within the limitations of the current study, we found that frozen section is a valuable tool for intraoperative evaluation of ovarian tumors with high accuracy for benign and malignant lesions. However, its limited sensitivity for benign ovarian tumors should be kept in mind before interpretation, and final histopathological diagnosis must be confirmed in such cases. Enhancing frozen section accuracy can be achieved by improved sampling techniques, awareness of tumor heterogeneity, and collaboration between surgical and pathology teams.

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