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Frozen section-Histopathology correlation in gynecologic pathology: A tertiary care centre experience

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Abstract:
Frozen section (FS) analysis provides rapid intraoperative diagnosis in gynecologic malignancies, aiding surgical management. This retrospective study analysed 124 FS cases from 2020 to 2024 and compared them with final histopathology. Ovarian masses were the most frequent specimens (37.9%), with FS diagnosing 73.4% benign, 2.4% borderline and 24.2% malignant tumours, while final histopathology showed 71% benign and 29% malignant cases. Overall diagnostic concordance was 83.1%, with FS showing 77.8% sensitivity, 94.3% specificity and 89.5% accuracy (κ=0.739, $p<0.001$). Thus, data shows that frozen section is a reliable intraoperative tool, especially for ovarian tumours, though limitations like tumour heterogeneity should be considered.

Keywords: Frozen section (FS), ovarian tumors, gynaecologic malignancies, histopathology correlation, intraoperative diagnosis, surgical management

Background:
Intraoperative frozen section is a valuable component of gynecologic malignancy surgery management since it provides the clinician with immediate critical information. The procedure facilitates rapid diagnosis of lesions and intraoperative decision-making, such as planning the extent of surgery and the post-operative management plan. Frozen section analysis is particularly valuable in gynecologic oncology since the rapid and correct differentiation between benign, borderline and malignant lesions is crucial to obtaining optimal patient outcomes. Gynecologic cancers, such as ovarian, endometrial and cervical malignancies, are considerable burdens on the healthcare systems of most countries. Of these, ovarian cancer has always been particularly tough to treat in most cases due to late diagnoses and nonspecific presentations. Ovarian tumors are one of the major lesions that are analyzed in frozen section analysis, with accurate intraoperative diagnosis sometimes greatly influencing the surgical approach **[1, 2]**. In such malignancy cases, the observed findings from the frozen section help in determining the degree of surgical staging or debulking, where improved prognosis and survival are achieved **[3]**. Frozen section analysis has shown a high sensitivity and specificity for gynecological pathology, especially when it comes to ovarian neoplasms. The values were above 90% **[4, 5]**. Borderline tumors can be wrongly categorized and results are size-dependent and heterogeneous; also, results vary on the skill of the pathologist involved **[6, 7]**. Despite these limitations, frozen section diagnosis continues to be a valuable and commonly used tool in assessing ovarian and other gynaecologic tumors intraoperatively. This correlation between frozen section and final histopathology provides a benchmark for the assessment of the precision and dependability of intraoperative diagnoses. The gold standard, histopathological examination, facilitates the comprehensive assessment of tissue morphology and a definitive diagnosis **[8]**. For ovarian tumors, literature shows high concordance between frozen section and histopathology, constantly underpinning the usefulness of frozen section in surgical decision-making **[9, 10]**. This study aims to assess the diagnostic accuracy of frozen section analysis in gynecological pathology, specifically focusing on ovarian neoplasms, in a tertiary care center. Correlation of findings from the frozen section with the final histopathological diagnosis was done to assess its sensitivity, specificity and predictive values. We have also identified pitfalls and limitations that may arise with its application to help optimize intraoperative diagnostic protocols. The outcomes of this research are expected to give insight into the clinical benefits of frozen section analysis in guiding surgical management for enhanced patient care in gynecological oncology **[11, 9]**. Therefore, it is of interest to report the correlation between frozen section and final histopathology in obstetrics and gynecological pathology in a tertiary care center.

Materials and Methods:
This is a retrospective study conducted in the Department of pathology and obstetrics and Gynaecology in the tertiary care institute of North India, over 5 years, from 2020 to 2024. A total of 124 cases were registered in the study. Institutional Ethics Committee approval was obtained before starting the study and informed consent was collected from all participants. The purpose of this study is to assess the accuracy of the diagnosis of intraoperative frozen section analysis in ovarian and other neoplasms by comparing the results with the final histopathological diagnoses. The study covered patients who were subjected to surgical excision of ovarian masses, adnexal masses, uterine masses and other obstetric and gynecological pathological conditions who had intraoperative frozen section evaluation followed by final histopathological analysis. Only cases with full clinicopathological data, including reports of both frozen section and histopathology, were considered. Cases with a deferred frozen section diagnosis or no follow-up

histopathology report were excluded from the study. During surgery, fresh tissue samples of pathological masses were sent for intraoperative frozen section analysis. The tissue samples were frozen at -20°C in a cryostat and 5-µm sections were cut and stained with H & E. The specimens were then carefully analyzed by the experienced pathologists and categorized into one of the three diagnostic categories: benign, borderline (intermediate), or malignant. All specimens, following surgery, underwent fixation in 10% formalin and processed for frozen section, followed by routine processing of the remnant of frozen by routine paraffin embedding, sectioning and staining with H&E. Final histopathological diagnoses were taken as the reference standard for comparison. The following demographic and clinical parameters were documented: age, menopausal status, presenting symptoms and tumor size. Continuous variables were reported with the use of mean and standard deviation for continuous data, such as age and numbers and percentages were used for reporting categorical data, like diagnostic categories and specimen types. The diagnostic performance of frozen section analysis was measured by calculating sensitivity, specificity, PPV, NPV and overall accuracy. The kappa (κ) statistic was used to calculate the degree of agreement between diagnoses by frozen section and histopathology and κ≥0.7 indicated an excellent agreement. A p-value of less than 0.05 was used to signify statistical significance. SPSS version 24.0 software was used for all statistical analyses.

Results:

One each adenomyoma, cystadenoma, cystadenoma/low grade carcinoma, cystic teratoma, endometriosis, follicular cyst, mature epithelial tissue, mature teratoma, multiloculated simple cyst, ovarian cyst, ovarian neoplasm, polyp, serous cyst, serous neoplasm, sex cord cell tumour, teratoma. One each epithelial malignancy, IM to malignant grade tumour, immature teratoma, minimal invasive VIN, mucinous adenocarcinoma, non-epithelial tumour, ovarian neoplasm + mixed germ cell tumour, metastasis, SCC, serous cyst BD papillary neoplasm, serous neoplasm. One each adenofibroma, adenomyosis with adenomyoma, angiofibroma, CIN I, corpus luteal cyst, cystic endometrioma, epithelial polyp, fibroma, follicular cyst, granulomatous inflammation, granulomatous salpingoophoritis, lymphangioma, negative for malignancy, no residual viable tumour, polyp, pyogenic salpingitis, serous borderline tumour, teratoma, torsion ovary, unremarkable. One each Adenosquamous carcinoma cervix, brenner's, dysgermioma, embryonal carcinoma, endometrial carcinoma, germ cell tumour, high-grade serous papillary adenocarcinoma, high-grade endometrial carcinoma, high-grade serous carcinoma, low-grade serous adenocarcinoma, mature cystic teratoma with PTC, metastasis, metastatic SCC, micro-invasive SCC, mixed germ cell tumour, mucinous adenocarcinoma, sclerosing stromal cell tumour, TAH+BSO endometrioid endometrial carcinoma. The patients' ages varied from 10 to 88 years, with a mean of 33.48 ± 13.16 years. The most frequent types of specimens received for examination were ovarian mass (37.9%), ovarian cyst (16.9%) and adnexal mass (16.9%), as demonstrated in **Table 1**. On frozen section examination, 91 cases (73.4%) were diagnosed as benign, 3 cases (2.4%) as intermediate and 30 cases (24.2%) as malignant. Among the benign cases, the most frequent diagnosis was "negative for malignancy" (n=40, 32.3%), followed by mucinous cystadenoma (n=10, 8.1%). Among the three intermediate cases, two were serous tumours and one was a mesenchymal neoplasm. Among the malignant cases, nine were "positive for malignancy," and others were malignant germ cell tumours (n=4, 3.2%) and granulosa cell tumours (n=2, 1.6%), as presented in **Table 2**. On final histopathology, 88 cases (71%) were diagnosed as benign and 36 cases (29%) as malignant. Among benign lesions, mucinous cystadenoma (n = 23, 18.5%) was the most frequent, followed by serous cystadenoma (n = 11, 8.9%) and leiomyoma (n = 10, 8.1%). Among malignant lesions, the most frequent diagnoses were high-grade serous adenocarcinoma (n = 4, 3.2%) and granulosa cell tumours (n = 2, 1.6%), as presented in **Table 3**. Frozen section diagnosis concurred with histopathology in 103 out of 124 cases (83.1%). Frozen section analysis had 28 true positives, 83 true negatives, 5 false positives and 8 false negatives in the identification of malignancy. Frozen section diagnosis for malignancy identification had a sensitivity of 77.8%, specificity of 94.3%, positive predictive value (PPV) of 84.8% and negative predictive value (NPV) of 91.2%, with a diagnostic accuracy of 89.5%. The kappa statistic revealed an excellent agreement between the frozen section and histopathology (κ=0.739; p<0.001).

Table 1: Age profile and specimen type (n=124)

S.No	Characteristic	Number	Percentage
1	**Mean(age)±SD (Range) in years**	33.48±13.16 (10-88)	
2	**Specimen type**		
	Ovarian mass	47	37.9
	Ovarian cyst	21	16.9
	Adnexal mass	21	16.9
	Endometrial tissue	4	3.2
	Vulval tissue	3	2.4
	Abdominopelvic mass	2	1.6
	Adnexal cyst	2	1.6
	Cyst wall	2	1.6
	Dermoid cyst	2	1.6
	Iliac lymph node	2	1.6
	TAH + BSO	2	1.6
	Tuboovarian mass	2	1.6
	Uterine fibroid	2	1.6

	Uterus with cervix	2	1.6
	Others	10	8.1
	(One each Cervical tissue, fibroid + adnexal cyst, Intra-abdominal mass, Leiomyoma, Myoma, Pelvic cyst, Pelvic LN, Polyp, Tuboovarian cyst and Uterus with cervix)		

Table 2: Diagnosis by frozen specimen

S.N	Characteristic	Number	Percentage
1	**Benign**	91	73.4
	Negative for malignancy	40	32.3
	Mucinous cystadenoma	10	8.1
	Mucinous neoplasm	5	4
	Cyst	4	3.2
	Leiomyoma	6	4.8
	Granulomatous pathology	2	1.6
	Serous tumor	2	1.6
	Sex cord stromal cell tumor	2	1.6
	Simple cyst	2	1.6
	Simple serous cyst	2	1.6
	Others*	16	15.3
2	**Intermediate**	3	2.4
	Mesenchymal neoplasm	1	0.8
	Serous tumor	2	1.6
3	**Malignant**	30	24.2
	Positive for malignancy	9	7.3
	Malignant germ cell tumor	4	3.2
	Germ cell tumor	2	1.6
	Granulosa cell tumor	2	1.6
	Malignant neoplasm	2	1.6
	Others**	11	8.9

Table 3: Diagnosis by histopathology

S.N	Characteristic	Number	Percentage
1	**Benign**	88	71
	Mucinous cystadenoma	23	18.5
	Serous cystadenoma	11	8.9
	Leiomyoma	10	8.1
	Fibrothecoma	4	3.2
	Simple cyst	4	3.2
	Endometriotic cyst	3	2.4
	Mature teratoma	3	2.4
	Dermoid cyst	2	1.6
	Endometriosis	2	1.6
	Hemorrhagic cyst	2	1.6
	Mature cystic teratoma	2	1.6
	Simple serous cyst	2	1.6
	Others*	20	16.1
2	**Malignant**	36	29
	High grade serous adenocarcinoma	4	3.2
	Granulosa cell tumor	2	1.6
	Immature teratoma (high grade)	2	1.6
	Squamous cell carcinoma	2	1.6
	Low grade Serous papillary carcinoma	2	1.6
	Yolk sac tumor	2	1.6
	Others**	18	14.5

Discussion:

The present study is designed to evaluate the clinical utility and diagnostic accuracy of intraoperative frozen section analysis in women referred to with lesions suspicious of gynaecological malignancies. Our findings indicate that FS analysis offers a rapid and reliable method for the diagnosis of malignancy in ovarian and other gynaecological tumours. The results of the present study showed that the sensitivity to detect malignancy was 77.8% and specificity 94.3%, with an overall accuracy of 89.5%. The present findings are consistent with the studies reported previously in the literature supporting the efficacy of FS in the intraoperative management of ovarian neoplasms. The present study shows a proportion of 24.2% malignant lesions on frozen sections compared to 29.0% on histopathology. The 83.1% agreement between FS and histopathological diagnoses proves the usefulness of FS for the immediate diagnosis needed to guide surgical decisions, particularly in malignancy management. Results are consistent with earlier research findings on the accuracy of FS analysis in ovarian tumours. Cuello *et al.* (1999) showed that FS analysis in ovarian tumours gives a reliable diagnosis, which helps in surgical decision-making **[6]**. Similarly, Begum *et al.* (2023) emphasised the role of FS analysis in intraoperative decision-making, particularly in ovarian cancer, by accurately identifying both benign and malignant lesions **[1]**. Limbachiya *et al.* (2025) evaluated the diagnostic accuracy of intraoperative frozen section in endometrial cancer and reported a high level of concordance of approximately 97% between frozen section findings and final histopathology. The study showed excellent diagnostic performance with a sensitivity of 96.9% and a specificity of 100%. Additionally, there was strong agreement in the assessment of tumour type and the depth of myometrial invasion. Based on these findings, the authors concluded that frozen section is a highly reliable intraoperative diagnostic tool in gynecologic pathology, playing a crucial role in guiding surgical decision-making **[12].** Goel *et al.* (2025) showed that intraoperative frozen section (FS) in ovarian tumours shows high diagnostic accuracy, typically exceeding 85%, with reliable differentiation between benign, borderline and malignant lesions. Similarly, other contemporary studies on gynecologic specimens have reported overall diagnostic accuracy in the range of 80–90%, with particularly high specificity for malignant tumours. Furthermore, our findings from tertiary care centres in North India add to the growing body of evidence supporting its clinical utility **[13]**. Similarly, Shukla *et al.* (2025) compared frozen section diagnoses with final histopathology in a tertiary health-care centre and showed the usefulness of frozen section as a rapid intraoperative diagnostic modality **[14]**. Their findings support the present observation that frozen section–histopathology correlation is valuable for assessing diagnostic reliability and guiding intraoperative surgical decisions. This result indicates the high specificity of FS in our study, which stands at 94.3%. This indicates its ability to correctly identify benign tumours and avoid unnecessary aggressive interventions. According to Hashmi *et al.* (2016), FS analysis is highly accurate for identifying benign ovarian tumours and thus avoiding unnecessary surgery for malignant tumors **[3]**. The high negative predictive value (91.2%) in this study indicates that FS has a great ability to rule out malignancy, so benign lesions would ensure that the majority of patients are spared from unnecessary surgery. The major limitation of this study was that malignancy was missed on FS in several cases that were later confirmed by histopathology. This flaw may have

been due to sampling error, heterogeneity of tumours, or false negatives due to some benign versus malignant types of tumours that FS is unable to differentiate. Other studies have also pointed to similar limitations. For example, Bajracharya Shakya *et al.* (2018) reported that in many cases, FS cannot detect all kinds of ovarian cancers, especially when the tumours are small or at an early stage. In such cases, a small number of tumour cells may not be present in the frozen section sample **[7]**. However, challenges notwithstanding, the overall diagnostic accuracy of FS in this study, given a kappa value of 0.739, which indicates excellent agreement between FS and histopathology, suggests the clinical utility of FS as an adjunct in the surgical management of gynaecological lesions. To that end, this high degree of agreement also falls in favour of using FS as an incredibly effective tool in the setting of surgical decision-making, especially in cases of suspected malignancies, where quick, reliable results are of paramount importance. The clinical benefits of FS in gynaecological cancers have been extensively researched, including in ovarian malignancies. Muruthapongsatorn *et al.* (2019) looked into the diagnostic accuracy of FS in ovarian tumours and found that FS analysis still plays an essential role in the intraoperative assessment of ovarian neoplasms, despite its shortcomings **[2]**. Likewise, Pujani *et al.* (2023) emphasised the FS role in early ovarian tumour diagnosis, hence further emphasising its clinical practice utility **[10]**. Similarly, Wootipoom *et al.* (2006) and Tempfer *et al.* (2007) showed the frozen section's importance in providing the best possible surgical treatment for borderline and malignant ovarian tumours **[4, 9]**. This study provides contemporary evidence supporting the high diagnostic accuracy and reliability of frozen section analysis in gynecologic pathology. The findings reinforce its role in intraoperative surgical decision-making while highlighting the impact of tumour heterogeneity and sampling limitations on diagnostic concordance.

Conclusion:

Frozen section showed good diagnostic accuracy and substantial concordance with final histopathology in gynaecologic lesions. Its high specificity supports its use in guiding intraoperative surgical decisions. Final histopathology remains essential, particularly in cases with diagnostic uncertainty.

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