Original Article

A Critical Appraisal of Intraoperative Frozen Section Analysis of Ovarian Tumors: A 3-Year Review of Accuracy and Clinicopathological Correlation at a Tertiary Care Center

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Abstract

Background: Intraoperative frozen section (IFS) plays a pivotal role in arriving at a diagnosis and guiding toward appropriate surgical management as there is a lack of effective ovarian cancer screening methods. Considering histopathology as the gold standard, the current study was conducted to examine the accuracy of frozen section in ovarian tumors. **Materials and Methods:** A prospective analysis was conducted on 52 cases of IFS of ovarian masses over 3 years (April 2018 to March 2021). Frozen section and permanent paraffin section reports were compared, and overall sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated. The role of various clinicopathological parameters in predicting ovarian malignancy was also evaluated. **Results:** The study group included 42 benign, 3 borderline, and 7 malignant tumors, with surface epithelial tumors being the most frequent. Discordance between IFS and histopathological diagnosis was observed in two cases. We observed a high sensitivity (90%), specificity (97%), PPV (90%), NPV (97%), and accuracy (94%) for frozen section of ovarian tumors. CA-125 ($P = 0.007$) and menopausal status ($P = 0.05$) emerged as significant for predicting malignancy statistically. **Conclusion:** Intraoperative frozen represents that section envisages pathologic examination in a time-bound manner and promotes fruitful communication between clinicians and pathologists, so that appropriate information is shared to curtail errors. Despite the small sample size, this study reiterates that frozen section serves as an effective diagnostic tool for intraoperative evaluation of ovarian masses when utilized judiciously by pathologists and surgeons as the advantages surpass the limitations.

Keywords: Diagnostic accuracy, frozen section, intraoperative assessment, ovarian cancer, ovarian tumors

Introduction

Ovarian cancers account for the eighth most common cancers among women globally, although much more frequent in developed vis-à-vis developing countries of the world.[1] The peak age for occurrence of ovarian cancers is peri/postmenopausal age and is relatively unusual in women under the age of 40. The risk factors associated with increased chances of developing ovarian cancers include advancing age, obesity, nulliparity, family history of cancers, and hormone therapy.[2]

Due to lack of effective ovarian cancer screening methods and nonspecific symptoms, around 65% of patients present at an advanced stage, therefore also referred to as "silent killer."[1] Currently, the most promising measures for early diagnosis include imaging and serum tumor markers. However, their role in distinguishing between benign, borderline, and malignant tumors is limited. Preoperative cytology and biopsy do not have great value in ovarian cancers. In addition, intraoperative diagnosis by imprint smear, scrape cytology, and fine-needle aspiration cytology have less accuracy compared to frozen section. Intraoperative frozen section (IFS) plays a pivotal

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role in arriving at a diagnosis and guiding toward appropriate surgical management (conservative in reproductive age group vs. radical surgery in postmenopausal).[2]

Although histopathology remains the gold standard, the overall accuracy of IFS in diagnosing ovarian malignancies has been documented as 73%–98% in the literature.[3-16] The index study was undertaken to assess the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of IFS in ovarian tumors.

Materials and Methods

Compliance with Ethical Standards:

1. Funding: This study was not supported by any funding.
2. Conflict of Interest: The authors declare that they have no conflict of interest.

3. Ethical approval: All procedures performed in studies were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

4. Informed consent: Informed consent was obtained from all individual participants included in the study.

5. Consent for publication: Consent for publication was obtained for every individual person's data included in the study.

IRB board name: Institutional Ethics Committee, ESIC Medical College & Hospital, faridabad Approval number – 134/A/11/15/Academics/MC/2016/98 Approved date -13.05.2019.

The present study was conducted in the histopathology laboratory, pathology department, where frozen sections were processed on the freshly received specimens of clinically suspected ovarian neoplasms from April 2018 till March 2021 (3 years). The study was conducted following prior approval from the institutional ethics committee, and written informed consent was obtained from the patients scheduled for frozen section prior to surgery.

Frozen section was planned for patients with raised CA-125 but clinically presenting with benign tumor either radiologically or on intraoperative examination), ovarian mass in a patient who had another malignancy in the past, and ovarian mass neoplasm in younger patients desirous of fertility preservation. The clinical data such as demographic data, case history, menopausal status, marital history, parity, any high-risk factors, clinical diagnosis, imaging studies, and serum tumor marker levels were retrieved from the case records.

Unfixed or fresh oophorectomy specimens or hysterectomy with salpingo-oophorectomy specimens which were sent intraoperatively to histopathology laboratory were used for frozen section procedure. The gross morphology of the ovarian masses was recorded. Representative sections were taken from the ovarian tumor including cyst wall and especially from solid areas. From all tumors, a minimum of three tissue bits were processed which included the cyst wall as well as solid areas if present. Additional sampling (4–5 tissue bits) was done for any tumor with size larger than 10 cm in the greatest dimension or with more solid component to get representative sections. The pieces from the cyst wall were put on the specimen chuck in a Swiss roll pattern and were frozen to −25°C using cryostat (Leica CM1950). Sections of 4–5 μ in thickness were cut as per protocol and stained with rapid hematoxylin and eosin (H and E) stain. A specific histologic diagnosis was given on frozen section as far as possible within 30 min of receipt of specimen. The various categories reported on frozen section were as follows: benign nonneoplastic conditions, epithelial neoplasm (further categorized as – benign, borderline, or malignant), ovarian germ cell tumor (subcategories – dysgerminoma, teratoma, and yolk sac tumor), ovarian sex cord-stromal tumor (subcategories – granulosa cell tumor and Sertoli–Leydig cell tumor), ovarian metastatic carcinoma, and a descriptive report in cases where no definite opinion could be rendered. Following frozen section reporting, the gross specimens were placed in formalin for fixation and processed routinely and paraffin blocks from the specimen as well as of the frozen bits were then cut and stained with H and E. Immunohistochemistry (IHC) was performed as and when required for confirmation of diagnosis or further subcategorization using antibodies for cytokeratin (CK), vimentin, inhibin, WT1, smooth muscle actin (SMA), desmin, estrogen and progesterone receptors, etc. (DAKO, Hamburg, Germany).

The final histologic diagnosis of ovarian lesions was according to the WHO classification.[7,14] A comparison was drawn between the frozen section diagnoses and final histopathologic diagnoses in each case considering it as gold standard. The cases where the diagnosis on frozen sections matched with the final histopathologic diagnosis with regard to the broad tumor category (benign, borderline, or malignant) for surface epithelial neoplasms or to cases in which major histologic category of primary ovarian malignancy (germ cell tumor and sex cord-stromal tumor) or to benign nonneoplastic conditions (endometriotic cysts) were labeled as concordant cases. The discordant cases were those where there was a mismatch between frozen section and histopathological diagnoses which could have adversely affected the intraoperative management. Both false positive (malignant or borderline frozen result, but benign on paraffin sections) and false negative (benign on frozen, but malignant or borderline on paraffin section) were included in discordant cases.

Statistical analysis

Diagnostic parameters such as sensitivity, specificity, PPV, and NPV of frozen section for diagnosis of ovarian neoplasms were calculated using the standard 2 × 2 method. The overall accuracy was defined as the total number of cases with

matching diagnosis between the frozen section and paraffin sections out of the total number of cases. The cases with discordant diagnosis were reviewed for any loopholes. The role of various clinicopathological parameters such as age, parity, menopausal status, CA-125, and tumor size was also evaluated in predicting ovarian malignancy. The statistical software SPSS version 21.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis.

Results

The study cohort included 52 ovarian masses received for IFS reporting over a period of 3 years, comprising 42 benign, 3 borderline, and 7 malignant tumors. Most of the women (51%) belonged to the age group of 21–40 years. The most frequent presenting symptoms were mass abdomen (60%) and pain abdomen (42%), followed by dyspepsia, menstrual cycle irregularities, constipation, and urinary symptoms in the descending order of frequency. In the current study, 42 (80%) patients were multiparous, while 86% were premenopausal. Thirty-nine cases (75%) had CA-125 levels more than 35 U/ml, while levels more than 250 U/ml were found in 10% of cases. Out of 52 cases, 5 (10%) had bilateral ovarian masses including serous cystadenoma in 2 cases and 1 case each of mucinous cystadenoma, benign cystic teratoma, and endometrioid carcinoma. On gross examination, 39 out of 52 (75%) were more than 10 cm in the greatest dimension. Most of the ovarian masses (70%) were cystic, followed by solid cystic (20%) and purely solid (10%). The detailed demographic and clinicopathological characteristics are depicted in Table 1.

Table 1: Demographic and clinicopathological profile of the study population (*n*=52)

Parameter	Subcategories	Frequency, *n* (%)
Age (years)	<20	7 (13.5)
	21-40	27 (51.2)
	41-60	17 (32.7)
	>60	1 (2)
Parity	Nulliparous	9 (17.3)
	1	1 (2)
	2	16 (30.8)
	3	12 (23.1)
	4	11 (21.2)
	≥5	3 (5.8)
Marital status	Unmarried	7 (13.5)
	Married	45 (86.5)
Menopausal status	Premenopausal	44 (84.6)
	Postmenopausal	8 (15.4)
CA-125 (IU/ml)	≤35	13 (25)
	>35	39 (75)
Laterality	Left	26 (50)
	Right	21 (40.4)
	Bilateral	5 (9.6)
Tumor size (cm)	<5	1 (2)
	5–15	28 (53.8)
	>15	23 (44.2)
Gross pathology	Cystic	36 (69.2)
	Solid-cystic	11 (21.2)
	Solid	5 (9.6)

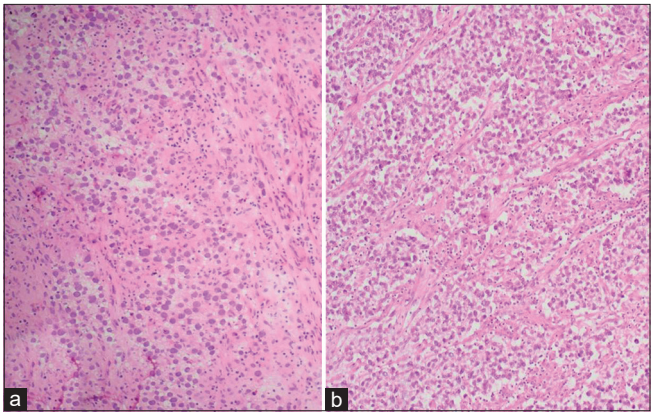

Figure 1: Photomicrograph showing ovarian epithelial malignancies. (a) Endometrioid carcinoma with the presence of glands (H and E, ×200), (b) Serous papillary cystadenocarcinoma (H and E, ×400; b inset). IHC: WT1 – strongly positive. IHC: Immunohistochemistry

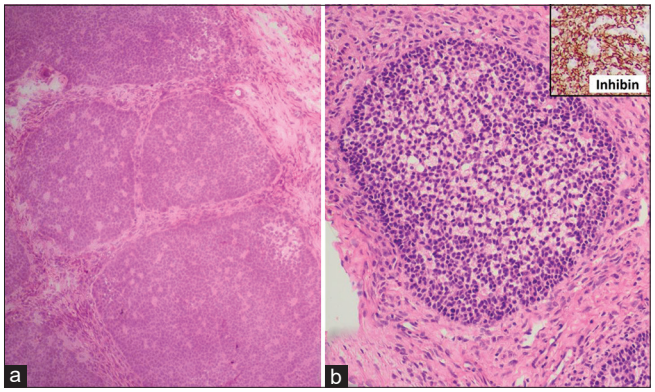

Figure 2: Photomicrograph showing germ cell tumors ovary. (a) Mature cystic teratoma with the presence of cartilage (H and E, ×100), (b) Dysgerminoma with clear cells and septa showing infiltration by lymphocytes (H and E, ×100; b inset). IHC: Inhibin positive (×100). IHC: Immunohistochemistry

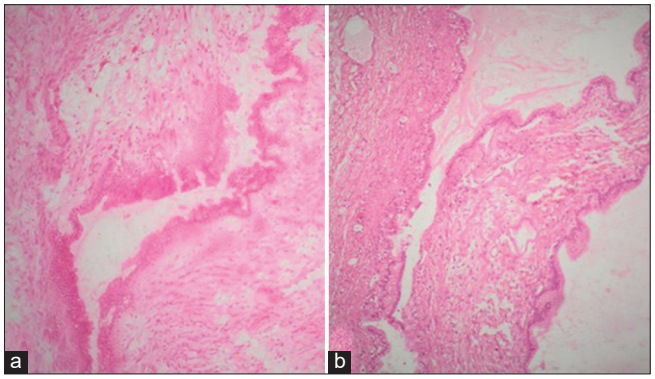

Figure 3: Photomicrograph showing sex cord-stromal tumor ovary. (a) Fibroma with fascicles of spindle cells and bland nuclear chromatin (H and E, ×100), (b) Granulosa cell tumor showing characteristic Call–Exner bodies (H and E, ×100; b inset). IHC: Inhibin positive (×100). IHC: Immunohistochemistry

Table 2: Spectrum of ovarian tumors based on histopathology

WHO category	Subcategory	Nature of tumor	Frequency (*n*)	Percentage
Surface epithelial-stromal tumors	Serous	Benign	15	61.5
		Borderline	2	
		Malignant	1	
	Mucinous	Benign	10	
		Borderline	1	
		Malignant	2	
	Endometrioid	Malignant	1	
Sex cord-stromal tumors	Fibroma	Benign	2	7.7
	Thecoma	Benign	1	
	Granulosa cell tumor	Malignant	1	
Germ cell	Teratoma	Benign	8	17.3
	Dysgerminoma	Malignant	1	
Miscellaneous	Leiomyosarcoma	Malignant	1	13.5
	Simple cyst	Nonneoplastic	2	
	Torsion	Nonneoplastic	1	
	Endometriotic cyst	Nonneoplastic	3	

WHO: World Health Organization

Table 3: A comparative analysis of frozen section diagnosis and final histopathological diagnosis (*n*=52)

Frozen section diagnosis	Final histopathological diagnosis		
	Benign	Borderline	Malignant
Benign (*n*=42)	41	1	0
Borderline (*n*=3)	1	2	0
Malignant (*n*=7)	0	0	7
Total (*n*=52)	42	3	7

Among the ovarian tumors, 42 (81%) tumors were reported as benign, 7 (14%) malignant, and 3 (6%) borderline on frozen section. According to the final histopathological report, 32 (62%) were surface epithelial tumors [Figure 1], 9 (17%) germ cell tumors [Figure 2], 4 (8%) sex cord-stromal tumors [Figure 3], 3 (6%) endometriotic cysts, 2 (4%) simple cysts, and one each was diagnosed torsion and leiomyosarcoma. The most common surface epithelial tumor was serous (15 benign, 2 borderline, and 1 malignant) accounting for 35% of cases [Figure 1]. One unusual case of leiomyosarcoma of ovary was reported. The spectrum of ovarian lesions observed on histopathology is detailed in Table 2.

Of the total cases, discordance in terms of category of tumors was observed in two cases (4%). The rest of the frozen section diagnosis (96%) matched with the final diagnosis given on paraffin sections. A comparative diagnosis given on frozen section and paraffin section is depicted in Table 3. One case was reported as borderline mucinous cystadenoma on frozen section, while it turned out to be benign mucinous cystadenoma on histopathology, thereby making it a false-positive diagnosis. On the contrary, a false-negative diagnosis was rendered for a borderline serous cystadenoma as a benign serous cystadenoma on frozen section [Figure 4]. The term "benign" being used included not only benign ovarian tumors but also benign

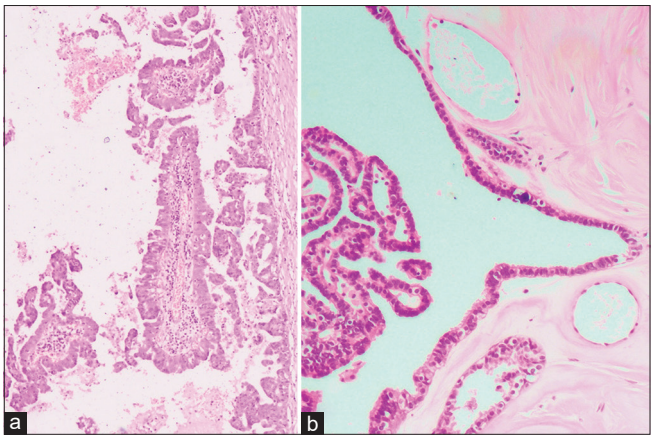

Figure 4: Photomicrograph showing false-negative case. (a) Reported as borderline ovarian serous cystadenoma on frozen section (H and E, ×100), (b) Diagnosed as benign ovarian serous cystadenoma on paraffin section (H and E, ×200)

nonneoplastic conditions such as endometriosis. Considering histopathology as the gold standard, the overall diagnostic accuracy of frozen section was 94%. In the current study, we observed a high sensitivity (90%), specificity (97%), PPV (90%), and NPV (97%) for frozen section of ovarian tumors.

Among the clinicopathological parameters which were analyzed as predictors of ovarian malignancy, CA-125 ($P = 0.007$) and menopausal status ($P = 0.05$) emerged statistically significant while age ($P = 0.115$), parity ($P = 0.628$), and tumor size ($P = 0.128$) did not.

Discussion

IFS helps in histological assessment of ovarian tumors which in turn guides the surgeons in appropriate surgical management of patients, in turn avoiding both over- and undertreatment. Moreover, some cases of endometriosis of ovary may mimic

malignancy so can be discovered on IFS.[5,7,10] A conservative approach is best suited for benign lesions, even borderline tumors, and a selected few young patients with malignant tumors with the aim to preserve their fertility. On the other hand, a radical approach comprising complete pelvic clearance, omentectomy, and appropriate staging procedure is indicated in malignant tumors. The primary objective of conducting IFS should be to accurately distinguish between benign, borderline, and malignant ovarian tumors and also recognize extraovarian malignancies.[9] The current study was conducted to assess the role of IFS in diagnosis of ovarian tumors.

In the present study, CA-125 levels were raised above 35 U/ml in 75% of our study group and in all the malignant tumors. The association between ovarian malignancy and raised CA-125 level was found to be statistically significant (P = 0.007). Vasilev *et al*. documented that CA-125 levels above 35 U/ml were found not only in most of the malignant masses (78%) but also in a small subset of benign masses (22%).[17]

The overall accuracy of IFS diagnosis of ovarian masses in our study was 94% which is in concordance with published literature. The overall diagnostic accuracy ranged from 86% to 97%.[3-16] A meta-analysis of 18 studies was conducted by Geomini *et al*. who observed a 65%–97% sensitivity of frozen section in diagnosing ovarian lesions and from 71% to 100% for malignant tumors. Benign tumors ranged in specificity from 97% to 100%, while 98.3%–100% specificity was found for malignant tumors.[18] A comparative analysis of various studies on IFS of ovarian tumors is shown in Table 4. Gultekin *et al*. concluded that the following factors affect the accuracy of IFS – tumor size, solid component, presurgical CA-125 levels, and integrity of the capsule.[32]

Stewart *et al*. documented different types of errors affecting the accuracy of IFS diagnosis, which include sampling errors, technical errors, and interpretation errors.[6] Sampling error accounted for majority of diagnostic discrepancies in most of the studies.[4,6] Owing to limited time during IFS, the pathologist can only select the most suspicious-looking areas for frozen sections, especially solid areas. However, for those ovarian tumors with no obvious solid area, only random sectioning can be done from the cyst wall, thereby enhancing the chance of sampling errors. Technical factor is rather underrated in most studies on frozen section diagnosis. Evaluation of cellular details is limited by the quality of sections prepared by this technique.

Mucinous tumors pose a greater challenge to the pathologist when performing IFS; this issue has been well addressed in most of the studies in the literature.[4,6] Large tumor dimensions and heterogenous nature were the predominant factors contributing to diagnostic difficulty in mucinous tumors. According to literature, a high proportion of mucinous tumors can show a variety of patterns such as co-existence of benign and borderline areas, borderline with foci of frankly invasive carcinoma, and sometimes a complete spectrum ranging from benign to borderline areas and focal invasive carcinoma. In mucinous tumors, the outpouching of the epithelium and formation of secondary glands make the assessment of stromal invasion more difficult compared to serous tumors.[33] Diagnosis of borderline mucinous tumors according to the WHO criteria is quantitative (in the absence of frank invasion, >10% of tumors should show atypical proliferative features); it may be misinterpreted on frozen section due to limited sections.[3,13] Wang *et al*. recommended taking one frozen section per each 10-cm diameter of the mass as multiple frozen section samples may help increase the accuracy in the diagnosis.[3] However, multiple frozen sections may not be able to eliminate the deferred or discordant cases as seen in many studies where up to 4 frozen sections were taken. On the contrary, multiple sections from different areas may be examined on paraffin sections which will lead to an accurate diagnosis in a heterogeneous lesion.

In certain instances where distinguishing borderline from malignant tumors becomes difficult, the term "at least borderline" may be used as a reasonable frozen section impression hinting that the final diagnosis might be modified but allows the surgeon to proceed with caution and perform a staging operation, thereby averting a second surgery.[12]

In the current study, one case was underdiagnosed as serous cystadenoma on frozen section instead of borderline. Owing to the large size of the ovarian mass, the representative areas may not have been sampled on IFS while in histopathology processing was much more extensive especially from the thickened wall. A case of a benign mucinous cystadenoma was overdiagnosed as borderline on IFS due to misinterpretation of the thick wall and stratification of lining. There are only rare instances of overdiagnosis on frozen sections with some examples where a false impression of invasion is given on account of tangential cutting like the case mentioned above.[13,34] There was a case of solid ovarian mass reported on frozen section as positive for malignancy; further categorization could not be done; however, it turned out to be a case of leiomyosarcoma which was confirmed by positive IHC staining for vimentin, SMA, and desmin. On account of high degree of pleomorphism and lack of morphological differentiation encountered on frozen sections, it was difficult to qualify the nature of malignancy and hence was signed out as being positive for malignancy.

Small sample size was the main limitation of our study, comprising heterogeneous nature of ovarian masses sent for IFS ranging from nonneoplastic benign lesions to frank malignancy. Individual pathologist performance may also act as a potential confounding factor.

Conclusion

Intraoperative frozen represents that section envisages pathologic examination in a time-bound manner and promotes fruitful communication between clinicians and pathologists, so that appropriate information is shared to curtail errors. There is high overall accuracy of IFS diagnosis of ovarian masses in our

Table 4: A critical appraisal of studies on intraoperative frozen section of ovarian tumors

Year	Authors	Country	*n*	Duration (years)	Type of tumor	SV	SP	PPV	NPV	DA	Remarks
2022	Present study	India	52	3	All	90	97	90	97	94	Two discordant cases (one FP and one FN)
2020	Palakkan *et al*.[16]	Kerala, India	60	1.5	B	95	100	100	88	-	71.7% - B, 6.7% - BL, 18.3% - M
					BL	90	97	90	97	-	
					M	75	94	50	98	-	
2019	Kung *et al*.[15]	Hong Kong	1143	11	B	100	92.5	95.7	100	97.2	Univariate regression analysis intact capsule, stage I lesions, and USG score 0 were positively associated with underdiagnosis
					BL	87.2	96.24	75.32	98.28	95.2	
					M	81.3	99.76	99.2	93.9	95	
2019	Gupta *et al*.[19]	India	81	1	All	76	98.2	95	90.2	91	100% concordance was observed between frozen section and scrape cytology
2019	Mukherjee *et al*.[20]	India	50	2	All	97.1	93.3	97.1	93.3	-	One case of FP, one was FN
2018	Md Arshad *et al*.[21]	Malaysia	92	9	B	95.6	85.1	86	95.2	83.7	-
					BL	76.2	88.7	66.7	92.7		
					M	69.2	100	100	88.7		
2018	Aidos *et al*.[22]	Portugal	184	5	B	100	97.1	99.3	100	-	Misdiagnosis in 2 cases - a borderline serous tumor and clear cell intracystic adenocarcinoma
					BL	66.7	99.4	66.7	99.4		
					M	96.9	100	100	100		
2018	Arora *et al*.[23]	Gujarat, India	292	7	B	100	94.28	-	-	96.2	Majority of discordant cases were mucinous and borderline tumors
					BL	65	99.26	-	-		
					M	96.67	99.42	-	-		
2017	Jena and Burela[14]	Karnataka India	49	3	B	93.5	90	100	90	89.7	No FP, 5 FN (all were mucinous ovarian neoplasms with mean diameter 26 cm)
					BL	72.7	100	100	92.6		
					M	58.3	100	100	88		
2016	Hashmi *et al*.[13]	Bangladesh	141	6	B	100	97			99	Underdiagnosis can occur in borderline tumors - minimized by increased sampling on FS
					BL	83	99				
					M	96	100				
2015	Mohammed and Ahuja[12]	Qatar	60	4	B	100	97.3			95.5	4 cases (6.6%) - frozen section diagnosis was deferred. 4 cases with discordance - all of these were FN
					BL	72.7	97.9				
					M	88.4	100				
2015	Abdelghany *et al*.[24]	Egypt	50	1	B		100	100	100	100	-
					BL	100	95	33.3	100	96	
					M		100	100		96	
2015	Ouladsahebmadarek *et al*.[25]	Iran	131	4	B	90.6	94.91	-	-	92.68	Scrape cytology has better DA than frozen section
					BL	-	-	-	-		
					M	94.9	90.62				
2015	Yazdani *et al*.[26]	Iran	126	5.5	B	99.1	90	-	-	94.4	0.9% FP cases, 1.8% FN. All inaccurate diagnosis were for epithelial tumors
					BL	80	95.9	-	-		
					M	66.7	100	-	-		
2014	Sukumaran *et al*.[11]	Kerala, India	233	3	B	99.2	90	100	90	91.8	19 discordant cases, 18 FN, and 1 FP
					BL	88.46	100	100	92.6	-	
					M	82.95	100	100	88	-	
2013	Subbian *et al*.[10]	Karnataka, India	135	2	B	90.4	82.6	-	-	84.3	-
					BL	31.2	94	-	-		
					M	91.5	98.2	-	-		
2013	Malipatil and Crasta[27]	India	218	10	B	99.3	92.6	-	-	95	Most of discrepant cases were from borderline category
					BL	86.7	97	-	-		
					M	96.3	100	-	-		

Contd...

Table 4: Contd...

Year	Authors	Country	*n*	Duration (years)	Type of tumor	SV	SP	PPV	NPV	DA	Remarks
2012	Khoddami and Ghavam[28]	Iran	187	13	B	99.3	100	-	-		71.7% - complete concordance
					BL	100	98.9	-	-		26.7% - partial concordance
					M	94.9	99.3	-	-		1.6% - discordant
2009	Rakhshan *et al*.[29]	Iran	282	14	B	99	-	-	-	95.7	Tumor size in discrepant cases was larger than concordant cases
					BL	60	-	-	-		
					M	92	-	-	-		No association between mucinous histology and inaccurate diagnosis was found
2008	Wasinghon *et al*.[30]	Thailand	376	5	B	98.2	88.6	92.2	-	87.8	Inaccuracy was 12.2%
					BL	61.8	93.8	63	-		
					M	79.6	97.1	91.1	-		
2008	Yarandi *et al*.[9]	Iran	106	2.5	B	97.4	-	-	-	93.3	2 FP, 3 FN, 2 overestimated diagnosis on frozen section
					BL	25	-	-	-		Accuracy of frozen section - 80% - serous tumors
					M	-	-	-	-		60% - mucinous tumors
2008	Suprasert *et al*.[8]	Thailand	112	5	B	100	92.7	-	-	94	Out of 18 patients - deferred/discordant cases, 72% were mucinous tumors
					BL	84	97.9	-			
					M	92	100	-			
2006	Wootipoom *et al*.[5]	Thailand	229	5	B	98.2	87	89.5	97.8	89.7	7% diagnosis deferred on frozen section
					BL	57.1	96.4	63.2	95.4		
					M	86.1	98.5	97.1	92.3		
2005	Ilvan *et al*.[31]	Turkey	617	9	B	100	97	-	-	97	21 cases FN, no deferred cases, majority of discordant cases were mucinous and borderline tumors
					BL	87	98	-			
					M	87	100	-			
					BL	-	-	62			
					M	-	-	100			

SV: Sensitivity, SP: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, DA: Diagnostic accuracy, B: Benign, BL: Borderline, M: Malignant, FN: False negative, FP: False positive, USG: Ultrasound

study. In the present study, the two cases were misdiagnosed on IFS. The major contributing factors accounting for discrepancy in frozen section diagnoses include sampling errors (limited number of frozen sections), technical errors (due to thicker frozen sections and freezing artifacts), and interpretive errors (inappropriate interpretation of sections). As a component of quality assurance, regular re-evaluation of cases with nonconcordance between frozen section and final paraffin section diagnoses should be conducted. Moreover, if two or more pathologists report the frozen sections, the errors can be minimized. Despite the small sample size, our study reiterates the significance of frozen section as an effective diagnostic tool for intraoperative evaluation of ovarian masses if utilized judiciously by pathologists and surgeons as the advantages outnumber the limitations.

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Conflicts of interest

There are no conflicts of interest.

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