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Advancing Diagnostic Precision: A Comprehensive Analysis of Frozen Section Efficacy in Lesion Detection across Diverse Anatomical Locations

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ABSTRACT

Introduction:

Histopathological analysis of tissue sections continues to be the preferred and definitive diagnostic method. However, frozen sections serve a purpose in rapid intraoperative diagnosis and guides patient management during surgery.

Aim:

The objective of the research is to study a range of lesions by frozen section at different anatomical locations and determination of efficacy of frozen section in terms of accuracy, sensitivity, and specificity.

Method:

This is a retrospective study conducted at the Department of Pathology, SIMS, RC, Bangalore from November 2021 to November 2023.The analysis of frozen section was done followed by its comparision with subsequent histopathology reports. The overall Accuracy,Sensitivity and Specificity were calculated along with Positive predictive value and Negative predictive values.

Results:

The study involved 100 cases with 91 female and 9 male patients, aged between 17 and 80. Among the cases, 58 were gynecological, 7 were related to breast, 6 involved oral cavity margins, and 5 focused on sentinel lymph nodes. The overall accuracy of the study was 98.8%, with sensitivity and specificity rate at 98.8% and 92.8%, respectively. Additionally, the positive predictive value was determined as 98.8%, while the negative predictive value stood at 92.8%.

Conclusion:

Validity of frozen section analysis is confirmed by the study's results on specificity, sensitivity, and accuracy, which closely align with those of prior research. However continual refinement and larger prospective studies are required to enhance diagnostic accuracy and reliability across diverse pathological process.

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Keywords: *Diagnostic accuracy;Frozen section analysis;Gynecological specimens; Histopathology;Sensitivity; Specificity; Positive predictive; Negative predictive value*

INTRODUCTION

The technique of frozen section (FS) was initially pioneered by William H. Welch at John Hopkins Hospital in 1891, gaining prominence for intraoperative consultation by the early to mid-1920s [1, 2]. Subsequent advancements in the 1950s and 1960s, notably the development of the modern cryostat—a refrigerated cabinet housing a microtome blade—simplified FS preparation [1,3]. FS serves the primary purpose of furnishing swift diagnoses crucial for guiding intra or perioperative patient care [1].

Moreover, the practice of FS in surgical pathology embodies an intricate skill passed down through generations of pathologists, often imparted through traditional "at the scope" teaching methodologies [4]. This technique represents a blend of historical evolution and contemporary technological innovations, contributing significantly to real-time diagnostic support during surgical procedures.

The primary purpose of performing a frozen section is to determine the nature of a lesion during immediate or intraoperative settings, especially in discerning between benign and malignant neoplasms, crucial for guiding patient management during surgery [5, 6]. Additionally, this technique is employed to assess surgical margins, detect lymph node metastasis in malignant lesions, and ensure the adequacy of tissue samples for subsequent paraffin section diagnosis [7,8]. Furthermore, frozen sections find utility in conducting enzyme histochemistry, immunohistochemistry, and immunofluorescence analyses, expanding their applications beyond basic histological assessment.

This study aims to evaluate the spectrum of lesions diagnosed using Frozen Section across several anatomical sites and to determine diagnostic Accuracy,Sensitivity and Specificity of Frozen Section in comparision with histopathology.

MATERIAL AND METHODS

This is a retrospective study carried out at the Department of Pathology, SIMS, RC, from November 2021 to November 2023. Approval from the Institutional Ethics Committee was obtained. A total of 100 cases with comprehensive clinical details and which had both frozen section and histopathology reports were included in the study. The data extraction process involved a meticulous review of records from the Hospital Information System (HIS) and manual archives.

Patient demographics, clinical diagnoses, lesion sites, and details of surgical procedures were documented alongside frozen section and histopathology reports. A comparative analysis between these diagnoses was conducted, categorizing cases as either concordant or discordant. Discordant cases underwent a further assessment with senior pathologists to identify the underlying causes for discrepancies.

Statistical analyses were performed using IBM SPSS version 25 and Microsoft Excel 2013. Descriptive assessments of variables were conducted using frequency and proportion measurements. Furthermore, the study calculated various metrics including prevalence rate, diagnostic accuracy, sensitivity, specificity, positive predictive value, and negative predictive value pertaining to the effectiveness of the frozen section technique.

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RESULTS

In this study comprising 100 patients, there were 91 females and 9 males, with an age range from 17 to 80 years. The majority of cases submitted for frozen section analysis originated from the gynecology department, representing 70% of the total sample, followed by 7% from breast cases.Details of other cases reviewed were provided in Table 3.

Out of 70 gynecology cases a total of 58 ovarian lesions were studied. Benign tumors accounted for 89.6% of cases, with a minimal percentage of malignancies at 10.3%. Table 1 details the specifics of these ovarian cases, outlining lesion types, their classifications as either benign or malignant, and distinct characteristics identified during frozen section analysis. Remarkably, complete agreement (100%) was observed between frozen section and histopathology reports for all cystic lesions and benign tumors. However, discrepancies surfaced in five cases, highlighting cases where the initial frozen section diagnosis diverged from subsequent histopathological evaluations.Among these discrepancies, two cases initially diagnosed as borderline tumors during frozen section analysis were identified as Granulosa cell tumors upon further histopathological examination. Additionally, cases initially reported as benign cystic lesion and sex cord stromal tumors during frozen section were later identified as Specialized Teratomas and High-grade Papillary Serous Carcinoma, respectively, in the final histopathology reports.

Table 2 delineates various gynecological specimens, excluding ovarian lesions, detailing their initial frozen section diagnoses, subsequent histopathology diagnoses, and the concordance or discordance between the two. Notably, for cases involving the uterus, cervix, and fibroids, the diagnostic accuracy was 100%, indicating alignment between the frozen section and histopathology findings for each specimen category.

Furthermore, Table 3 presents a breakdown of various specimens analyzed via frozen section and subsequent histopathology diagnoses. Concordance between frozen section and histopathology was evident across multiple cases, encompassing oral cavity margin status, sentinel lymph nodes, lymph node status, parathyroid, omentum, soft tissue masses, and others (such as Para Pelvic Cyst). However, discordance arose in two parotid cases due to interpretation errors and one gall bladder case due to a sampling error.

Initial diagnosis of High-grade Mucoepidermoid carcinoma via Frozen Section [Fig. 1] later revealed as a Warthin tumor with squamous metaplasia and extensive necrosis on histopathology, accentuating the diagnostic challenges in frozen section analysis. Another example of discordant diagnosis found in our study is a case of Castleman disease which is reported as Pleomorphic adenoma on Frozen section [Fig.2].

The concordance findings on Frozen section and histopathology was observed in cases of High grade serous carcinoma[Fig.3],Liposarcoma [Fig 4],Endometrial carcinoma[Fig.5]. and a case of metastatic deposits of Granulosa cell tumor [Fig 6].

DISCUSSION

The precision of frozen sections varies across institutions based on the nature of surgical cases and the expertise of involved pathologists. The accuracy of frozen section diagnoses is contingent upon the anatomical site under examination. Routine self-audits conducted by surgeons and pathologists aid in comprehending their proficiency in the frozen section service. These audits, pooling data from numerous institutions and scrutinizing individual performance, indicate that over 95% of cases

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receive accurate diagnoses. Merely 2 to 15% of cases present discrepancies from the original diagnosis, while in a small fraction, ranging from one to four percent, diagnosis deferral occurs until a permanent section is available [9].

The outcomes from our study resonate with findings from previous research, mirroring the concordance rates reported by [10,3,11]. However, studies by [12 and 13] demonstrated higher concordance rates of 96.9% and 97% respectively, accompanied by lower discordant rates of 3.1% and 5%.

In our study the Positive Predictive value is 98.8% and Negative Predictive value is 92.8% which is comparable to studies by [14,5 and 15].These comparative analyses emphasize variations in agreement between frozen section and histopathology in different studies.

In our evaluation of breast lesions, both benign and malignant, achieved a notable accuracy of 100%, %, akin to Varnika et al's study, which showcased 100% accuracy for malignant lesions and 95.9% for benign ones. In the context of ovarian tumors, while Krithiga et al documented an overall accuracy rate of 93.3%, our study revealed a 91.3% concordance rate alongside an 8.6% discordant rate.

Our study, conducted over two year with a sample size of 100 cases, demonstrated commendable performance metrics. Specifically, our study achieved an accuracy rate of 98.8%, showcasing the precision and reliability of the frozen section technique in diagnosing tissue samples. Moreover, the sensitivity and specificity rates, both at 98.8% and 92.8%

respectively, underscore the robustness and discerning capability of this diagnostic method. When juxtaposed with findings from other research (Table 5) [11, 12, 17, 18 and 19], our study's performance measures demonstrate competitiveness, occasionally even surpassing, in terms of accuracy, sensitivity, and specificity.

Discordance rates between Frozen Section (FS) and Formalin-Fixed Paraffin-Embedded (FFPE) tissue diagnoses are compared on a regular basis as part of quality evaluations to evaluate workload complexity, measure test reliability, and identify frequent error-prone areas. Furthermore, these analyses support decision-making related to laboratory certification [20].

Our study's limitations primarily stem from a limited spectrum of observed lesions, except for ovarian cases, as the majority of cases were received from the gynecology department, followed by breast and oral cavity cases. Fewer cases were obtained from various sites such as Parotid, Pancreas, Parathyroid, Omentum, and Soft tissues with minimal representation was observed from the gastrointestinal tract (GIT).We did not receive sample from Thyroid, Bones and Joints, Brain, etc. Additionally, the reliance on archived records might introduce variability due to inconsistencies or missing data in documentation.To overcome these limitations, prospective studies with larger sample sizes and stringent protocols are essential.

CONCLUSION(S)

The study underscores the widespread utilization of the frozen section technique within surgical oncology and OBG departments at SIMSRC. Its successful application suggests the potential benefits of extending its implementation across additional departments, promising a substantial improvement in patient care. This practice presents an invaluable learning opportunity for postgraduate students, technicians, and consultants.Despite achieving an overall accuracy of 98.8%

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and notable sensitivity and specificity levels of 98.8% and 92.8%, respectively, the study emphasizes larger prospective studies across diverse anatomical sites and lesion types.

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Table 1. Details of ovarian cases

Specimen	No.of cases	Percentage
Simple cyst	3	5.17%
Paraovarian cyst	1	1.72%
Benign cyst	6	10.34%
Cyst with features of Torsion	5	8.62%
Endometriotic cyst	5	8.62%
Dermoid cyst	6	10.34%

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Serous cystadenoma	14	24.14%
Mucinous cystadenoma	10	17.24%
Borderline tumor	1	1.72%
Cystadenocarcinoma	3	5.17%
Fibroma	2	3.45%
Granulosa cell tumor	2	3.45%

Table 2. Showing details of Gynecology Cases (Excluding Ovarian Cysts and Masses)

Table 3.Details of different specimens submitted for frozen section and histopathology diagnosis

Specimen	**No.of Cases**	**Percentage (%)**	**Frozen section diagnosis**	**Hisopathology diagnosis**	**Concordant/ discordant**
Specimen	**Frozen Section diagnosis**	**No.of Cases**	**Hisopathology diagnosis**	**Concordant/ Discordant**	
TAH+BSO	Endometrial carcinoma	5	Endometrial carcinoma	C	
TAH+BSO	Endometrial hyperplasia without atypia	2	Endometrial hyperplasia without atypia	C	
TAH+BSO	Negative for malignancy	1	Negative for malignancy	C	
TAH	Leiomyoma	1	Leiomyoma	C	
Fibroids	Leiomyoma	2	Leiomyoma	C	
Cervical mass	Positive for malignancy	1	Adenosquamous carcinoma	C	
Breast: Carcinoma margins status	4	7%	Margins free	The Margins free in all cases	C
Lump;To rule out malignancy	3		Negative for malignancy	Negative for malignancy	C
Oral cavity: Margins status	5	6%	The Margins free in all cases	The Margins free in all cases	C

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Ca tongue Lip growth	1				
Sentinel Lymphnode	5	5%	4 cases:Negative 1 case:Positive	4 cases:Negative 1 case:Positive	C
Lymphnode status	1	2%	Positive for malignancy	Positive for malignancy	C
Parathyroid	1	1%	Parathyroid adenoma	Parathyroid adenoma	C
Gall bladder	1	1%	Benign adenomatous polyp	Benign adenomatous polyp with carcinoma in situ	D
Parotid	2	2%	Pleomorphic adenoma Mucoepidermid carcinoma probably high grade	Castleman's disease Warthin tumor with Squamous metaplasia with extensive necosis	D D
Pancreas	1	1%	Malignancy can not be ruled out	Chronic sclerosing cholangitis	C
Omentum	2	2%	Positive for deposits	Positive for deposits	C
Soft tissue Retroperitoneal mass	1 1	2%	Liposarcoma Positive for malignancy	Liposarcoma Malignant spindle cell tumor	C C
Others:Parapelvic cyst	1	1%	Benign cystic lesion-?Inflammatory	Inflammed parapelvic cyst	C

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Table 4:Comparision of Concordance and discordant rate of present study with various studies.

Name of the study	Study period (Years)	No.of cases	Concordance rate	Discordant rate
Patil P et al [11]	2	100	96.9%	3.1%
Chbani et al [12]	1	261	95%	5%
Tangde A et al [13]	1	83	91.57%	8.43%
Purbesh et al [14]	1	41	90.2%	9.8%
Chandramouleswari K et al [3]	1	51	92%	-
Present study	2	100	92%	8%

Table 5: Comparison of Accuracy, Sensitivity and Specificity of Present Study with Various Studies.

Name of the study	Study period (Years)	No.of cases	Accuracy %	Sensitivity %	Specificity %
Patil P et al [11]	2	100	96.96	97.23	96.30
Tangde A et al [13]	2	83	91.57	85.71	97.92
Satish selvakumar et al [15]	5	518	98.65	90.91	96.59
Junn-Liang et al [16]	1	1084	97.7	96.16	99.43
Farah-Klibi F et al [17]	3	1207	97.5	84.6	99.8
Present study	1	100	98.8	98.8	92.8

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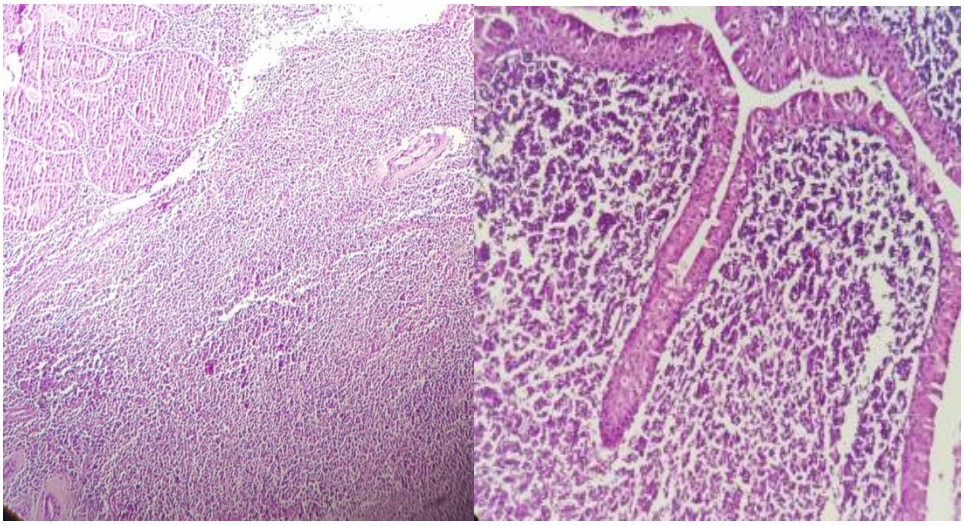


Figure 1. The initial Frozen Section (FS) diagnosis indicated a high-grade Mucoepidermoid carcinoma, which was later identified as a Warthin tumor with squamous metaplasia and extensive necrosis upon conventional histopathological examination.

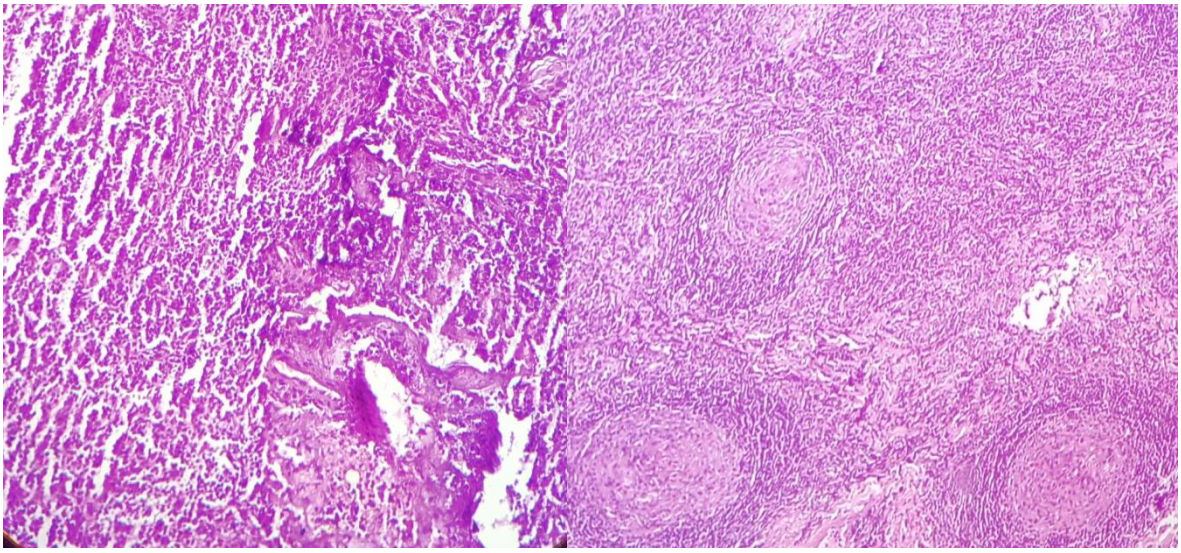
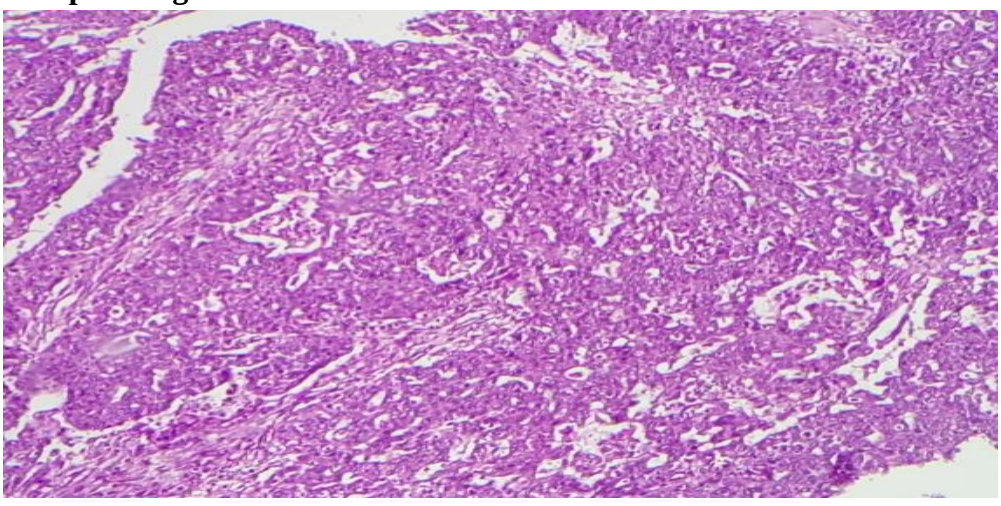


Figure 2. The Frozen Section (FS) diagnosis of pleomorphic adenoma, with the subsequent histopathological assessment as Castleman disease.



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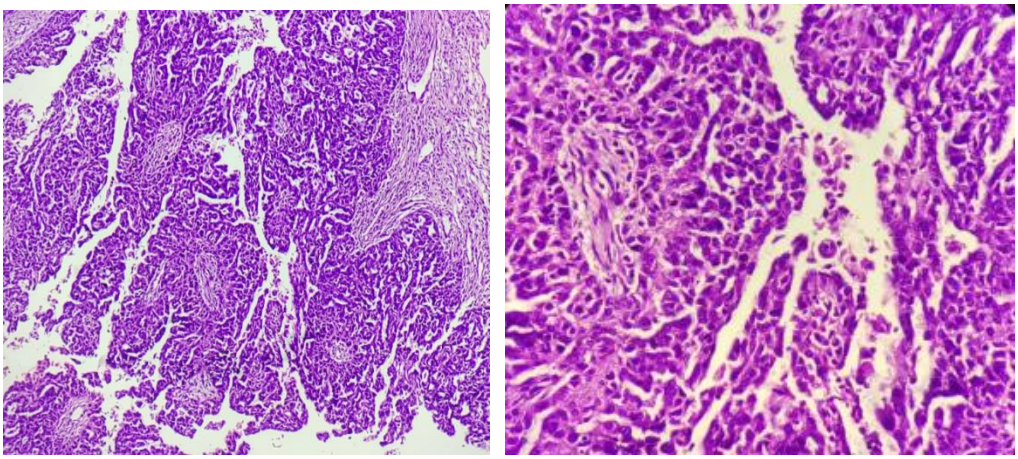

FIG 3. The histopathological diagnosis of High-grade serous tumor of Ovary aligned with the Frozen Section (FS) diagnosis of High-grade serous tumor.

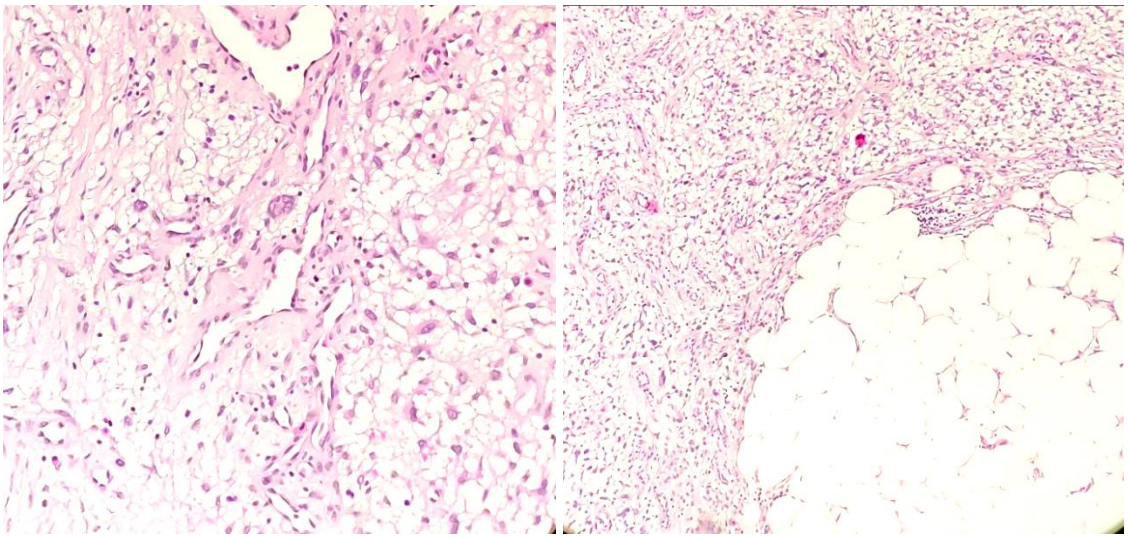

Figure 4. The diagnosis of Liposarcoma exhibited concordance between the Frozen Section (FS) and histopathology diagnoses.

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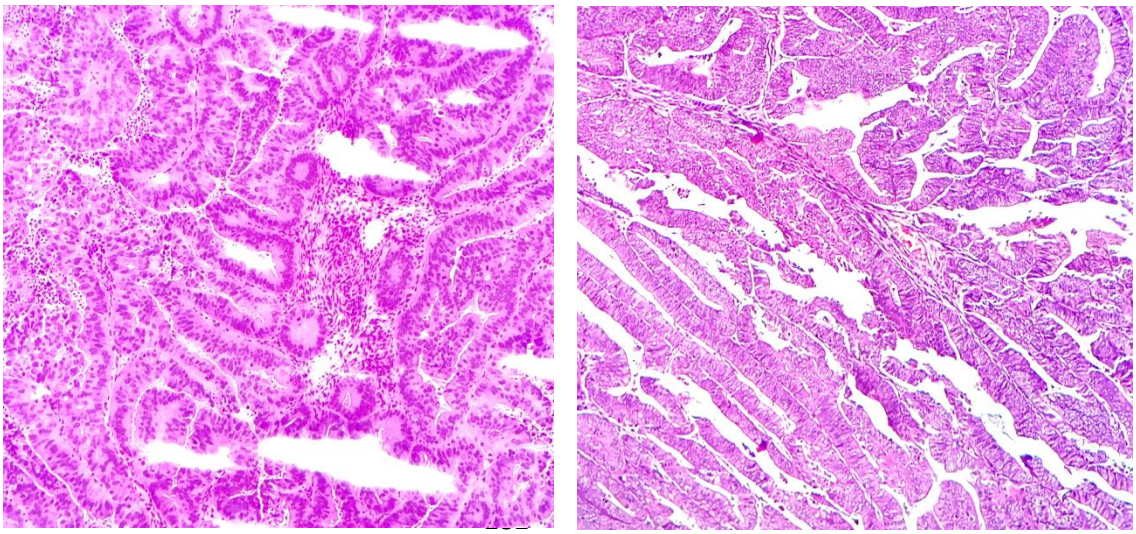

Figure 5: Consistent diagnosis of Endometrial carcinoma between frozen section and conventional histopathology

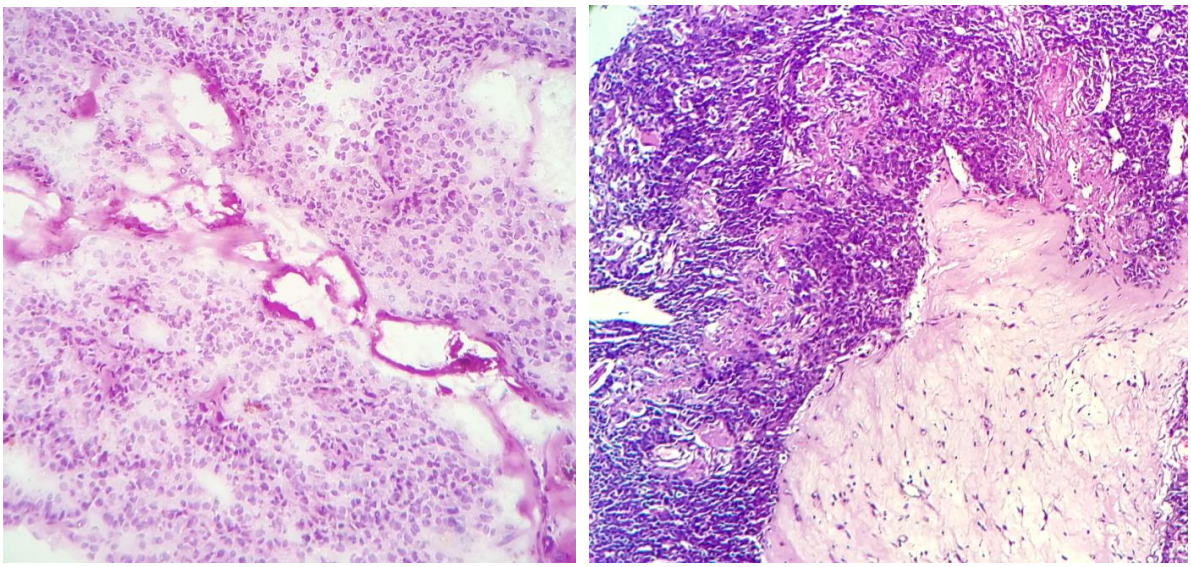

Figure 6. Concordant Diagnosis of Positive for malignancy was made on FS with Metastatic deposts of Granulosa cell Tumor on histopathogy,