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ASSESSING THE DIAGNOSTIC ACCURACY OF FROZEN SECTION REPORTING: A RETROSPECTIVE COMPARISON WITH HISTOPATHOLOGY

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ABSTRACT

Background: The diagnostic accuracy of frozen section analysis is of paramount importance in surgical pathology, serving both in the management of surgical patients and as a quality control measure. This study evaluated the diagnostic accuracy of frozen sections over an 18-month period at a teaching hospital in Bareilly, India.

Methods: A retrospective review was conducted on frozen sections performed at the Pathology Department of Rohilkhand Medical College And Hospital, Bareilly, UP, India, from January 2024 to June 2025. The results were compared with permanent sections to ascertain the diagnostic accuracy, sensitivity, and specificity of the frozen section test. Cases with discrepancies were re-evaluated to identify the underlying causes of the differences.

Results: A total of 186 frozen section specimens were analyzed. Of these, 171 cases (92%) were concordant with the permanent diagnoses, while 15 cases (8%) were not. The specimens primarily originated from the oral mucosa, breast, ovary, and lymph nodes. The overall sensitivity, specificity, positive predictive value, and negative predictive value of the frozen section compared to the permanent section (considered the gold standard) were 90.9%, 94.2%, 97.56%, and 80.32%, respectively. Among the 15 discordant diagnoses, seven (46.6%) were attributed to sampling errors, and eight (53.3%) were due to interpretative errors.

Conclusion: Frozen section analysis is a reliable and precise diagnostic tool that can be trusted in surgical management. The findings of this study also indicate that the accuracy of frozen section diagnosis at our institution is consistent with internationally published rates.

INTRODUCTION

Frozen sections represent an expeditious diagnostic technique employed during surgical procedures to furnish immediate histological evaluations. This method was initially introduced by William H. Welch at Johns Hopkins Hospital in 1891 and subsequently refined as a diagnostic tool by Cullen Wilson McCarty and colleagues.[1]

The procedure of frozen sectioning is conducted using Cryostat equipment, proving particularly advantageous for delineating tumor margins, assessing lymph node involvement, and facilitating real-time surgical decision-making. The primary advantage of frozen sections lies in their rapidity, enabling pathologists to provide critical information to surgeons within minutes, thereby potentially reducing the necessity for additional surgeries.[2] Furthermore, this method preserves tissue architecture more effectively than cytological smears, resulting in more accurate diagnoses. Nonetheless, frozen sections have limitations, such as offering less detailed histological information than permanent sections, the potential for artifacts due to rapid freezing, and a smaller sample size that may not fully represent the entire lesion. The accuracy of frozen sections can also be compromised in certain tissue types, such as fatty tissues or those with high water content. Despite these limitations, when judiciously applied and interpreted by skilled pathologists, frozen sections remain an essential tool in surgical pathology, balancing the need for prompt diagnosis with diagnostic precision.[3]

In this study, we examined and compared the diagnoses from frozen sections and permanent sections of various tissues and organs over 18 months to evaluate diagnostic accuracy and analyze any discrepancies in the results.

MATERIALS AND METHODS

This study presents an 18-month retrospective analysis examining cases submitted for frozen section evaluation at the pathology department of Rohilkhand Medical College and Hospital in Bareilly, UP, from January 1, 2024, to June 30, 2025. During this period, 186 tissue samples were received for frozen section analysis and intraoperative consultation, encompassing a variety of malignant and non-malignant conditions.

Fresh tissue samples were delivered to our department in clean plastic containers filled with normal saline, accompanied by a completed requisition form from the operating room. Following a gross examination and necessary measurements, the specimens were dissected, and samples were taken from representative areas. The frozen sectioning was performed at temperatures between -20°C and -22°C, with sections cut to a thickness of 4 to 5 microns and immediately stained with rapid H & E (Hematoxylin and Eosin). At least two pathologists interpreted the stained tissue sections, and the diagnosis was communicated via telephone. The average turnaround time (TAT) was 20 minutes, and a provisional printed report was provided to the patient for documentation.

The remaining tissue from each case was fixed in 10% buffered formalin, processed, and permanent sections were prepared from paraffin blocks. After H & E staining, these were reported and compared with the frozen section slides. A diagnosis was deemed concordant if it matched the permanent section diagnosis, and discordant if it did not. In cases of discordance, both frozen and permanent section slides were reviewed, along with any additional history and investigations, by 2-3 pathologists. The causes were analysed, documented, and the surgeon was informed of the final diagnosis.

RESULTS

During the 18-month duration of our study, a total of 186 frozen section specimens were obtained from the surgical departments. The age of the patients ranged from a 5-month-old infant to 80 years. The highest frequency of cases was observed in the age group of 41 to 50 years (32.08%), followed

by 31 to 40 years (20.96%) and 51 to 60 years (20.43%). A predominance of female patients was noted in our study.

The tissues submitted for frozen section analysis were primarily derived from the oral cavity, female genital tract, lymph nodes, breast. The indications for conducting frozen sections were as follows: 1) to establish a definitive diagnosis (79.05%); 2) to evaluate lymph node status (10.75%); 3) to rule out malignancy (7.52%); 4)to assess margin status (1.61%) and 5) to detect the presence of ganglion cells in Hirschsprung's disease (1.07%).

Of the total 186 cases, the diagnoses from frozen sections and permanent sections were concordant in 171 cases (92%) and discordant in 15 cases (8%) (Table 1). Among the discordant cases, five were from the oral cavity, two from the female genital tract, three from the breast, two from the intestine, and one each from the lymph node,thyroid and kidney. The reasons for discrepancies were assessed by reviewing the frozen section slides. Among the 15 discordant cases, the discrepancies were attributed to sampling error in seven cases (46.6%) and misinterpretation in eight cases (53.3%).

DISCUSSION

The frozen section technique is widely recognized as a reliable and accurate diagnostic tool that assists surgeons during intraoperative procedures. However, it is associated with substantial costs and technical limitations, making it typically accessible only in large medical institutions equipped with the necessary personnel who possess the requisite technical expertise, skills, and equipment. The interpretation of frozen sections presents greater challenges compared to the examination of paraffin-embedded sections. Even when performed by highly skilled medical laboratory technicians, the procedure may result in the lesion appearing more severe than it would in a paraffin section of fixed tissue. Consequently, a competent pathologist must be aware of what to anticipate, what to examine, and how to formulate a sound conclusion without resorting to excessive ingenuity.[4]

In the present study, we reviewed the frozen sections in our department to evaluate the diagnostic accuracy of the test in our institution. The overall accuracy of frozen section diagnosis reported in the literature varies from 92% to 97.98%.[5,6,7] Our study shows an accuracy rate of 92%, which falls within the reported range. We also reviewed the discordant cases to identify the cause of the discrepancy. The total number of concordant cases were 171 out of the total 186 cases (92%), with discordant cases accounting for 15 out of 186 (8%). No case was deferred; hence, it was not included in our study.

The total number of concordant cases in the present study was 171 (92%), which is similar to a study conducted by Shrestha et al.[7], who reported an overall concordance of 94.6% and discordance of 5.4% over a five-year study period. Similarly, a study by Chandramouleeswari K et al.[8] reported an overall concordance percentage of 92% over one year, with a discordance percentage of 2%, which was lower than our study. They noted that discrepancies were mainly due to inherent limitations of frozen sections in organs like the thyroid. Our results were comparable to similar studies regarding the accuracy, deferral, concordant, and discordant rates in frozen section and permanent section diagnosis.

The diagnostic accuracy of the frozen section was 92% in our study, which is comparable to other studies such as Preeti A et al.[11] (94.2%) and Chandramouleeswari K et al.[8] (92%). In our study, the sensitivity was 90.9%, specificity 94.2%, positive predictive value 97.56%, and negative predictive value was 80.32%, which was comparable to a study conducted by Hatami H et al.[12], with a sensitivity of 92.95%, PPV 98.50%, specificity 99.55%, and negative predictive value 97.80%. These results were comparable with other studies as listed in Table 6.

Among the discordant cases, five involved specimens of oral cavity mucosa. In the frozen sections, no evidence of malignancy was detected in all five cases; however, the permanent sections revealed

moderately differentiated squamous cell carcinoma. Of these five cases, three were attributed to interpretation errors, while the remaining two were due to sampling errors. Another series of discordances was observed in two cases of ovarian tissue. One was initially reported as benign mucinous cystadenoma on the frozen section but was later identified as borderline mucinous tumor on the permanent section, with the cause attributed to interpretation errors. In another ovarian case, the frozen section was reported as negative for malignancy, but the permanent section revealed well-differentiated endometrioid carcinoma. Similarly, three cases from the breast were found to be discrepant. Two of these were reported as negative for malignancy on the frozen sections but were later identified as invasive breast carcinoma of no special type on the permanent sections, due to sampling errors. In the remaining one case from breast tissue, it was reported as invasive carcinoma of no special type on the frozen section, but the permanent section identified it as proliferative breast disease, attributed to interpretation error. Other cases and their causes are detailed in Table 4.

Acquiring experience is crucial for the precise acquisition of biopsy samples, their processing, and the analysis of frozen section slides. In instances of uncertainty, the involvement of two or even three observers in the evaluation of specimens can significantly reduce errors. Implementing appropriate measures and enforcing stringent guidelines can further contribute to decreasing failure rates.

CONCLUSION

The frozen section technique is a reliable and accurate method when applied to tumor resection margins, lymph node metastasis, and tissue identification. An accurate diagnosis necessitates a comprehensive patient history, clinical and imaging findings, and a strong collaboration with the operating surgeon, in addition to systematic gross examination, precise sampling, and the avoidance of technical errors in sectioning and staining.

In cases of suspected malignancy, examining multiple samples is crucial to reduce the likelihood of a false-negative diagnosis in frozen sections. A methodical gross/macroscopic examination, precise sampling by the pathologist, and the avoidance of technical mistakes in sectioning and staining, along with effective communication with the operating surgeon, can mitigate limitations and provide the rapid, reliable, and cost-effective information needed for swift diagnosis and on-table patient management.

Continuous monitoring should be conducted in every pathology department to identify the causes of errors and, if possible, to minimize them and enhance the turnaround time for frozen sections.

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Table1: Tissue Types with concordance and discordance.

Tissue Type	*Total No. Of Cases*	*Concordant*	*Discordant*
Oral Cavity	80	75	05
Female Genital Tract	42	39	02
Lymph Nodes	20	19	01
Breast	15	13	03
Intestine	12	10	02
Gall Bladder	07	07	00
Surgical Margins	03	03	00
Thyroid	03	02	01
Salivary Gland	02	02	00
Kidney	02	01	01
Total	**186**	**171**	**15**

Table 2: True Positive, False Positive, True Negative and False Negative Cases.

True Positive	-	120	False Positive	-	03
False Negative	-	12	True Negative	-	49

Table 3: Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Accuracy

Sensitivity(%)	**Specificity(%)**	**Positive Predictive Value (%)**	**Negative Predictive Value (%)**	**Accuracy(%)**
90.9%	94.2%	97.56%	80.32%	92%

Table 4: Discordant cases between frozen and permanent sections.

Types Of Tissue	**Diagnosis in frozen section**	**Diagnosis In permanent section**	**Cause for discordance**	**Number of cases**
Ovary	Negative for malignancy	Well differentiated Endometriod carcinoma.	Sampling error	1.
Kidney.	Uninvolved by tumor	RCC (chromophobe type).	Sampling error	1.
Breast	Invasive breast carcinoma	Proliferative breast disease	Interpretation error	1.
Thyroid	Possibility of neoplastic lesion cannot be ruled out.	Simple colloid goitre	Sampling error	1.

Lymph Node	Reactive Lymphnode	Large cell non keratinizing SCC-cervix.	Interpretation error	1.
Colonic Mucosa	Negative for malignancy	Adenocarcinoma	Interpretation error	2.
Breast	Negative for malignancy	Invasive breast Carcinoma_NST.	Sampling error	2.
Oral Cavity Mucosa	Negative for malignancy/tumor	Moderatey differentiated SCC	Interpretation error	3.
Ovary	Benign mucinous cystadenoma	Borderline mucinous ovarian tumor.	Interpretation error	1.
Oral Cavity Mucosa	Negative for malignancy/tumor	Moderatey differentiated SCC	Sampling error	2.

Table 5: Comparison of Present study with various similar studies.

S.No	Authors	Study Period (Years)	No.Of Cases	Concordance (%)	Discordance (%)
1.	**Shrestha et al.[7]**	5	404	94.6	5.4
2.	**Saumya Mishra et al.[9]**	2	52	96.2	3.8
3.	**Chbani et al[10]**	1	261	95	5
4.	**Chandramouleeswari K et al[8]**	1	51	92	2
5.	**Patil et al[13]**	2	100	96.9	3.1
6.	**Present Study**	1.5	186	92	8

Table 6: Comparison of Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value with Various other Studies

	Hatami H et al[12]	Bhardawaj S et[14] al	Fariba Abbasi et al[15]	Present Study
No. of cases	295	200	200	186
Sensitivity(%)	92.95	80.50	93.2	90.9
Specificity(%)	99.55	98.50	97.7	94.2
PPV(%)	98.50	96.70	---	97.56
NPV(%)	97.80	94.9	---	80.32