**Original Article**

# Diagnostic Value of Frozen Section in Surgical Pathology Specimens: A Retrospective Study at Shahid Rahimi Hospital (2021–2024)

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## Abstract

**Background:** Frozen section (FS) examination is a widely used intraoperative diagnostic technique that provides rapid histopathological assessment to guide surgical decision-making. However, its diagnostic performance across different tissue types remains an important clinical consideration. This study aimed to evaluate the diagnostic accuracy of FS in thyroid, breast, and ovarian specimens by comparing its results with permanent histopathological diagnoses.

**Methods:** This analytical cross-sectional study included 199 pathology records of thyroid, breast, and ovarian specimens collected from 2021 to 2024 at Shahid Rahimi Hospital, Khorramabad, Iran. Cases were selected using stratified simple random sampling. Frozen section results were compared with permanent histopathology, which was considered the gold standard. Diagnostic performance indices including sensitivity, specificity, positive predictive value, and negative predictive value were calculated using SPSS version 22.

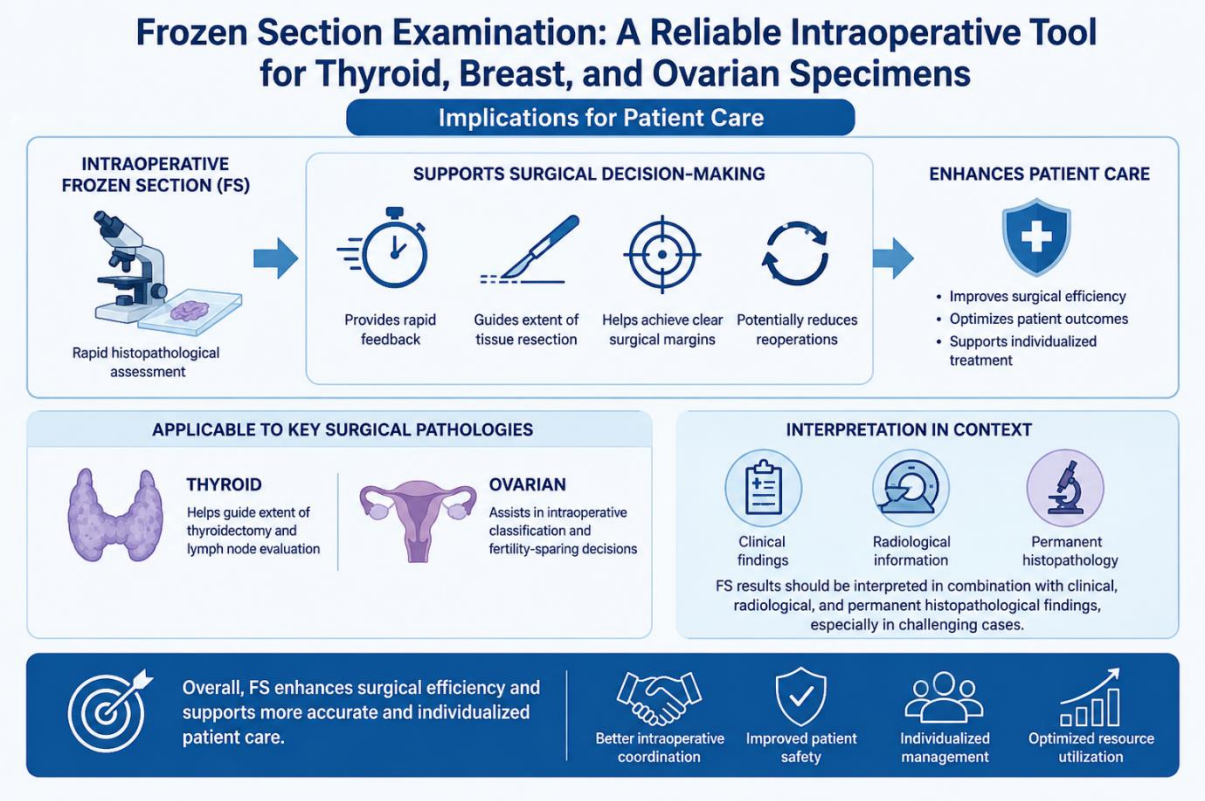
**Results:** The mean age of patients was 47.35 ± 12.04 years, and most cases were female (96%). Breast specimens accounted for 67.8%, followed by thyroid (30.7%) and ovarian (1.5%) samples. FS showed complete concordance with permanent histopathology, with no false-positive or false-negative cases identified. Accordingly, sensitivity, specificity, PPV, and NPV were all 100% across all specimen types.

**Conclusion:** Frozen section examination demonstrated high diagnostic accuracy and complete concordance with permanent histopathology in thyroid, breast, and ovarian specimens. FS remains a reliable intraoperative tool that supports surgical decision-making, although its limitations in specific tumor types highlight the continued importance of permanent section diagnosis.

**Implications for Patient** Care: Frozen section (FS) examination may support intraoperative decision-making by providing rapid histopathological information, helping guide the extent of surgery and potentially reducing

reoperations. FS results should be interpreted with clinical, radiological, and permanent histopathological findings, especially in challenging cases. Overall, FS may enhance surgical efficiency and support individualized patient care.

**Keywords:** Frozen section; Intraoperative diagnosis; Thyroid neoplasms and Breast cancer and Ovarian tumors; Diagnostic accuracy; Surgical pathology




**Graphical Abstract. Role of Frozen Section in Intraoperative Surgical Decision-Making and Patient-Centered Care.** This graphical abstract illustrates the role of frozen section (FS) analysis in intraoperative surgical decision-making and patient-centered care. FS provides rapid histopathological feedback during thyroid, breast, and ovarian procedures, supporting optimization of resection extent, reduction of reoperations, and multidisciplinary decision-making in conjunction with permanent histopathology.

## Introduction

Intraoperative consultation through macroscopic and microscopic evaluation of tissue specimens is a critical service provided by pathologists, requiring precision, expertise, and rapid assessment (1). This service is crucial because frozen section (FS) enables immediate histopathological diagnosis during surgery, guiding surgeons on tissue removal, margin assessment, and further intervention (2, 3). FS is particularly valuable in thyroid, breast, and ovarian pathology. In the thyroid, it facilitates rapid identification of nodules suspicious for malignancy and evaluates surgical margins, potentially reducing unnecessary surgery (4, 5). In the breast, FS enables immediate assessment of masses, verification of clear margins, and informed decisions regarding lymph node dissection (6). In the ovary, FS supports rapid differentiation of benign, malignant, or borderline lesions and guides fertility-sparing surgical approaches (7). The advantages of FS include rapid turnaround, reduction of re-operations, optimization of surgical decision-making, and

preservation of healthy tissue and organ function (2). Frozen section allows rapid intraoperative evaluation of tissue and can be applied in various clinical settings, including community hospitals with limited resources or urgent cases (8). Despite its advantages, FS has limitations, such as reduced accuracy in borderline or specific tumor types, lower tissue quality compared to paraffin-embedded samples, and high dependency on the pathologist's experience (9). Previous studies have demonstrated high diagnostic accuracy of FS for clearly benign or malignant tumors, while performance is limited in borderline lesions, emphasizing that permanent paraffin sections remain essential for definitive diagnosis (10).

The present study aims to evaluate the diagnostic accuracy and quality control of frozen section analysis in thyroid, breast, and ovarian specimens at Shahid Rahimi Hospital, examining the practical role of FS in surgical decision-making and patient management.

## Methods

### *Study Design and Setting*

This analytical cross-sectional study was conducted to evaluate the diagnostic performance of frozen section (FS) in thyroid, breast, and ovarian specimens. The study was conducted in the Diagnostic Pathology Laboratory of Shahid Rahimi Hospital, Khorramabad, Iran. All eligible pathology records from 2021 to 2024 were included. Patients who had undergone surgical biopsy of thyroid, breast, or ovarian tissue during the study period were considered for inclusion. All records were initially stratified according to tissue type (thyroid, breast, and ovary), and within each stratum, cases were selected using simple random sampling to ensure balanced representation across groups. Records with incomplete or missing essential information were excluded from the final analysis. The study protocol was approved by the Ethics Committee of Lorestan University of Medical Sciences (IR.LUMS.REC.1404.199), and all patient data were anonymized prior to analysis to maintain confidentiality.

### *Study Population and Sample Size*

The sample size was estimated based on a diagnostic accuracy of 0.87. A 95% confidence level and a precision of 0.1 were assumed. The minimum required sample size was 43 cases per tissue group, including thyroid, breast, and ovarian specimens. This corresponded to a total minimum of 129 cases. To increase statistical power and strengthen the robustness of the findings, all eligible records within the study period were included. The final sample size was 199 cases.

### *Data Collection*

After obtaining ethical approval, data were retrieved from archived hospital pathology records. The extracted variables included patient age, sex, tissue type, frozen section (FS) diagnosis, and corresponding permanent histopathological diagnosis. The permanent section diagnosis was considered the reference standard against which the diagnostic performance of FS was evaluated.

### *Statistical Analysis*

Data were analyzed using SPSS software version 22.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were summarized as frequencies and percentages. Diagnostic performance indices, including sensitivity, specificity, positive predictive value, negative predictive value, and false-positive and false-negative rates, were calculated separately for each tissue type. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test, as appropriate. For continuous variables, independent samples t-test or non-parametric equivalents were applied depending on data distribution, and one-way

analysis of variance (ANOVA) was used when comparing more than two groups. A p-value of less than 0.05 was considered statistically significant.

## Results

### 1. Descriptive Statistics

A total of 199 pathology records were included in the analysis. The mean age of patients was 47.35 ± 12.04 years, and most cases were female (191/199, 96%). Regarding specimen distribution, breast samples accounted for 135 cases (67.8%), followed by thyroid with 61 cases (30.7%), and ovarian specimens with 3 cases (1.5%). The distribution of demographic characteristics and specimen types is presented in Table 1. In summary, the analyzed cohort mainly consisted of middle-aged women, with breast specimens representing the predominant sample type.

### 2. Diagnostic Performance of Frozen Section (FS)

Frozen section (FS) results were compared with permanent histopathology, which was considered the reference standard. Overall, FS demonstrated complete agreement with permanent section diagnoses, with no false-positive or false-negative cases identified.

Consequently, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were all 100%, indicating perfect concordance between the two methods (Table 2). These results support the reliability of FS as an accurate intraoperative diagnostic method.

| Variable | | N | % |
|---|---|---|---|
| Sex | Female | 191 | 96.0 |
| | Male | 8 | 4.0 |
| Specimen Type | Breast | 135 | 67.8 |
| | Thyroid | 61 | 30.7 |
| | Ovary | 3 | 1.5 |
| Age (Years) | - | 47.35 ± 12.04 | - |

**Table 1. Frequency distribution of age, sex, and specimen type.** The study population predominantly consisted of middle-aged women, with breast specimens accounting for the majority of cases.

| Fs Diagnosis | Permanent Benign N (%) | Permanent Malignant N (%) |
|---|---|---|
| Benign | 32 (100) | 0 (0) |
| Malignant | 0 (0) | 167 (100) |

**Table 2. Cross-tabulation of FS and permanent section diagnoses.** Frozen section diagnoses showed complete concordance with permanent histopathology findings, with no false-positive or false-negative results observed.

### 3. Diagnostic Accuracy by Specimen Type

When analyzed according to tissue type, frozen section maintained perfect diagnostic performance across all categories. Sensitivity, specificity, PPV, and NPV were consistently 100% for breast, thyroid, and ovarian specimens,

demonstrating uniform diagnostic reliability across different anatomical sites (Table 3). In summary, the diagnostic concordance between FS and permanent histopathology remained uniformly high across all specimen types.

| Specimen Type | TP | FP | TN | FN | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) |
|---|---|---|---|---|---|---|---|---|
| **Breast** | 132 | 0 | 3 | 0 | 100 | 100 | 100 | 100 |
| **Thyroid** | 34 | 0 | 27 | 0 | 100 | 100 | 100 | 100 |
| **Ovary** | 1 | 0 | 2 | 0 | 100 | 100 | 100 | 100 |

**Table 3. Diagnostic performance of frozen section by specimen type.** Frozen section demonstrated perfect diagnostic performance across all specimen types, with no false-positive or false-negative cases observed.

## DISCUSSION

The results of this study demonstrate that frozen section (FS) examination provided 100% concordance with permanent section diagnoses across thyroid, breast, and ovarian specimens. These findings support the high diagnostic accuracy of FS and reinforce its role as a reliable intraoperative tool for guiding surgical decision-making. By allowing immediate assessment of lesion characteristics and surgical margins, FS can help optimize the extent of tissue removal, reduce unnecessary reoperations, and improve patient outcomes. These results are consistent with previous studies reporting high sensitivity and specificity of FS, particularly in breast and ovarian tumors, while highlighting that careful handling and experienced pathologists remain critical to maintaining diagnostic precision. Overall, the study reinforces the clinical value of FS in surgical pathology as a rapid and dependable technique for real-time decision-making.

Frozen section (FS) remains a cornerstone of intraoperative pathology, providing surgeons with rapid, real-time diagnostic information that directly impacts clinical decision-making (11). When properly performed, FS demonstrates high concordance with permanent section diagnoses, highlighting its reliability as a tool for intraoperative decision-making, as demonstrated in studies on ovarian tumors (12). Furthermore, these results are consistent with international studies showing high diagnostic accuracy of FS, while certain lesions, particularly follicular or borderline cases, may still require permanent sections to assess capsular and vascular invasion (10, 13).

In thyroid surgery, FS plays a critical role in determining the extent of thyroidectomy and guiding decisions regarding central or lateral lymph node dissection (14, 15). While FS is highly accurate in papillary thyroid carcinoma and clearly benign nodules, its limitations in follicular neoplasms emphasize that definitive diagnosis still relies on permanent histology (16). In breast surgery, FS facilitates precise evaluation of tumor margins and sentinel lymph nodes, allowing immediate intraoperative decisions that minimize the risk of re-excision, preserve normal tissue, and reduce operative time and anesthesia exposure (6). For ovarian tumors, FS can distinguish benign, borderline, and malignant lesions intraoperatively, guiding fertility-sparing surgery and informing staging procedures, which is particularly critical in younger patients (17, 18).

Importantly, the observed perfect concordance may partly reflect case selection bias, as only

cases with clearly interpretable frozen section and complete histopathological correlation were included. Additionally, the relatively small number of indeterminate or borderline lesions in the present cohort may have contributed to the absence of diagnostic discrepancies. Furthermore, the study was conducted in a single tertiary care center with experienced pathologists, which may have enhanced diagnostic performance and limits generalizability to other settings. These results should be interpreted cautiously given the retrospective design and potential spectrum bias.

Overall, this study reinforces FS as a highly dependable, real-time tool in surgical pathology. Its integration into operative protocols for thyroid, breast, and ovarian procedures not only enhances diagnostic confidence but also improves patient safety and resource utilization. Future multicenter research could further clarify its utility in challenging histologists, refine guidelines for intraoperative use, and quantify its long-term impact on surgical outcomes and healthcare efficiency.

## Conclusion

Frozen section (FS) examination demonstrates high diagnostic accuracy across thyroid, breast, and ovarian specimens, showing complete concordance with permanent section diagnoses in the present study. FS provides rapid, real-time histopathological information that supports intraoperative decision-making, optimizes the extent of tissue removal, minimizes unnecessary reoperations, and enhances patient safety. While FS is highly reliable, its limitations in certain tumor types—particularly follicular neoplasms and borderline lesions—highlight the continued importance of permanent paraffin sections for definitive diagnosis. The integration of FS into surgical protocols for thyroid, breast, and ovarian procedures reinforces its role as a cornerstone of intraoperative pathology. Future multicenter studies are warranted to validate these findings in larger and more diverse populations, refine guidelines for complex cases, and better assess the long-term impact of FS on surgical outcomes and healthcare efficiency.

### Implications for Patient Care

Frozen section (FS) examination can be considered a useful intraoperative tool that supports timely surgical decision-making in thyroid, breast, and ovarian procedures. By providing rapid histopathological feedback, it may assist in guiding the extent of tissue resection and contribute to more accurate surgical management, potentially reducing the need for reoperation.

In oncologic surgery, FS may facilitate intraoperative decision-making where balancing complete tumor removal with tissue preservation is essential for optimal patient outcomes. Nevertheless, FS findings should be interpreted in conjunction with clinical, radiological, and permanent histopathological results, particularly in borderline or diagnostically challenging lesions, where definitive diagnosis still relies on permanent sections.

Overall, FS may improve coordination between surgical and pathology teams and support more individualized patient management, while its optimal use should be defined within a multidisciplinary clinical framework and further validated in larger multicenter studies.

### Conflict of Interest

The authors declare that they have no conflict of interest.

### Author Contributions

All authors contributed to the conception and design of the study, literature search, data interpretation, drafting of the manuscript, and critical revision of the article. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.

**Ethics Statement**

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

**Data Availability Statement**

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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