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Diagnostic Efficacy of Intraoperative Cytology in Relation to Histopathology: A Prospective Study from a Tertiary Care Center

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ABSTRACT

Background: Intraoperative cytology (IOC), including squash, scrape, and imprint techniques, serves as a rapid diagnostic tool during surgical procedures. It provides immediate guidance to surgeons, particularly in differentiating benign from malignant lesions. Histopathology remains the gold standard for definitive diagnosis. The present study was undertaken to evaluate the diagnostic efficacy of intraoperative cytology in comparison with histopathological examination.

Methods: This prospective comparative observational study was conducted in the Department of Pathology at a tertiary care center over one year. A total of 50 specimens from various anatomical sites were evaluated using intraoperative cytology techniques (squash, scrape, and imprint) and subsequently correlated with formalin-fixed paraffin-embedded histopathology. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy were calculated.

Results: Of the 50 cases, 41 (82%) were females and 9 (18%) were males, with the majority belonging to the 41–60 years age group (48%). Malignant lesions constituted 50% of cases. Intraoperative cytology demonstrated 100% concordance for malignant and tubercular lesions and 95.7% concordance for benign lesions. The overall sensitivity and specificity were 96.15% and 95.83%, respectively, with PPV of 96.15%, NPV of 95.83%, and overall diagnostic accuracy of 96%.

Conclusion: Intraoperative cytology is a rapid, cost-effective, and highly accurate diagnostic modality with excellent correlation to histopathology. It plays a crucial role in real-time surgical decision-making and serves as a reliable alternative in settings where frozen section facilities are unavailable.

Keywords: *Intraoperative cytology, Squash smear, Imprint cytology, Scrape cytology, Histopathology, Central nervous system tumors.*

INTRODUCTION

Histopathology has long been regarded as the gold standard for tissue diagnosis in both clinical practice and research settings. However, conventional paraffin-embedded histopathological examination requires several hours to days for processing, which limits its utility in situations requiring immediate surgical decision-making [1]. Intraoperative consultation plays a crucial role in guiding surgeons regarding the nature of a lesion, margin status, lymph node involvement, and adequacy of resection during ongoing procedures.

Frozen section examination is the conventional method used for rapid intraoperative diagnosis. Although highly effective, it requires specialized infrastructure, technical expertise, and may introduce freezing artifacts that compromise

cellular details [2,3]. In resource-limited settings, frozen section facilities may not always be available, necessitating alternative rapid diagnostic techniques.

Intraoperative cytology (IOC), including squash smear, scrape cytology, and imprint (touch) cytology, has emerged as a reliable and cost-effective alternative for rapid diagnosis [3,4]. These techniques are simple, rapid, and require minimal equipment while preserving excellent cytomorphological details. Scrape cytology has been shown to provide rapid assessment of resection margins and tumor characterization with good diagnostic accuracy [1,5]. Similarly, imprint cytology offers high cellular clarity and has been widely used in the evaluation of breast, thyroid, ovarian, and soft tissue lesions [6].

Squash cytology is particularly valuable in the evaluation of central nervous system (CNS) tumors due to the soft and friable nature of neural tissue [7,8]. It allows excellent visualization of nuclear morphology and cytoplasmic features without the freezing artifacts commonly seen in frozen sections. Several studies have reported diagnostic accuracy ranging from 83% to 97% for intraoperative cytology when correlated with histopathology [3,4,9].

The major advantages of intraoperative cytology include rapid turnaround time, low cost, minimal tissue requirement, and preservation of cellular details [3,4]. However, limitations such as sampling errors, difficulty in tumor grading, and inability to assess depth of invasion must be considered [10].

Given the increasing demand for rapid intraoperative diagnosis and the growing reliance on cytological techniques, the present study was undertaken to evaluate the diagnostic efficacy of intraoperative cytology (squash, scrape, and imprint) in various anatomical sites and to compare its findings with the gold standard histopathological examination.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective comparative observational study conducted in the Department of Pathology at Jaipur National University Institute for Medical Sciences and Research Centre (JNUIMSRC), Jaipur. The study was carried out over a period of one year, from 15 March 2023 to 15 March 2024, after obtaining approval from the Institutional Ethics Committee.

Sample Size

The sample size was calculated using the formula $N = (Z\alpha)^2 \times p \times q / L^2$, where $Z\alpha$ was taken as 2.576 at a 99% confidence interval, p was assumed to be 50%, q (1 − p) was 50%, and the permissible error (L) was 1%. Based on this calculation, the minimum required sample size was 50 cases, and accordingly, a total of 50 specimens were included in the study.

Inclusion Criteria

- All resection specimens and biopsies from tumors or tumor-like lesions sent for intraoperative evaluation.
- Cases from all age groups and both genders.

Exclusion Criteria

- Purely cystic or fluid specimens lacking solid areas.
- Inadequate or acellular smears.

Specimen Handling and Processing

Fresh surgical specimens were received intraoperatively in saline without fixative. Clinical details were obtained from the requisition forms. Gross examination was performed, and representative tissue fragments (approximately 1–2 mm in size) were selected for cytological evaluation.

Intraoperative Cytology Techniques

Three cytological techniques were employed:

1. Squash Smear Technique

Small tissue fragments (≤2 mm) were placed on a clean glass slide and gently compressed using another slide without excessive pressure. A minimum of 5–8 smears were prepared per case. The smears were immediately fixed in 95% ethanol and stained using rapid Hematoxylin and Eosin (H&E). This technique was primarily used for central nervous system (CNS) lesions and other soft tissue fragments.

2. Scrape Cytology

After gross inspection and sectioning of the specimen, the most representative area was selected. The tissue surface was gently scraped using a scalpel blade or edge of a glass slide. The material obtained was spread onto clean glass slides in a

manner similar to fine needle aspiration cytology (FNAC). Smears were fixed in 95% ethanol and stained with rapid H&E; air-dried smears were stained with May–Grünwald–Giemsa (MGG) when required.

3. Imprint (Touch) Cytology
Freshly cut surfaces of tumor specimens were gently touched onto clean glass slides to obtain cellular impressions. The smears were immediately fixed in 95% ethanol and stained using rapid H&E or MGG stain.

Histopathological Examination
The remaining tissue was fixed in 10% buffered formalin and processed routinely for paraffin embedding. Sections were stained with conventional H&E and examined microscopically. Histopathology served as the gold standard for final diagnosis.

Tumor grading on squash cytology was compared with histopathological grading where applicable.

Statistical Analysis
Data were entered into Microsoft Excel and analyzed using SPSS software.
Cytological diagnoses were compared with histopathological findings and categorized as:

- True Positive (TP)
- True Negative (TN)
- False Positive (FP)
- False Negative (FN)

The following statistical parameters were calculated:

- **Sensitivity** = TP / (TP + FN) × 100
- **Specificity** = TN / (TN + FP) × 100
- **Positive Predictive Value (PPV)** = TP / (TP + FP) × 100
- **Negative Predictive Value (NPV)** = TN / (TN + FN) × 100
- **False Positive Rate (FPR)** = FP / (FP + TN) × 100
- **False Negative Rate (FNR)** = FN / (FN + TP) × 100
- **Diagnostic Accuracy** = (TP + TN) / Total cases × 100

Percentages and proportions were used for descriptive analysis. Concordance between intraoperative cytology and histopathology was assessed.

RESULTS
A total of 50 cases were evaluated by intraoperative cytology and correlated with histopathology.

Table 1. Demographic and Diagnostic Distribution of Cases (n = 50)

Variable	Category	n (%)
Gender	Male	9 (18%)
	Female	41 (82%)
Age Group	<20 years	1 (2%)
	21–40 years	17 (34%)
	41–60 years	24 (48%)
	>60 years	8 (16%)
Intraoperative Diagnosis	Benign	23 (46%)
	Malignant	25 (50%)
	Inflammatory	1 (2%)
	Tubercular	1 (2%)

Majority of cases were females (82%) and most patients belonged to the 41–60 years age group (48%).

Table 2. Age-wise Distribution of Diagnostic Categories (Intraoperative Cytology)

Diagnosis	<20 yrs	21–40 yrs	41–60 yrs	>60 yrs	Total
Benign	0	8	11	4	23
Malignant	1	7	13	4	25
Inflammatory	0	1	0	0	1
Tubercular	0	1	0	0	1

Malignant lesions were most common in the 41–60 years group (n=13).

Table 3. Specimen and Department-wise Distribution

A. Specimen Distribution

Specimen	n (%)
Adnexa/Ovary	21 (42%)
Brain	11 (22%)
Spine	7 (14%)
Uterus with cervix	3 (6%)
Gall bladder	3 (6%)
Others (LN, mandible, stomach, appendix)	5 (10%)
Total	50 (100%)

B. Department Distribution

Department	n (%)
Obstetrics & Gynecology	21 (42%)
Neurosurgery	18 (36%)
General Surgery	5 (10%)
Onco-Surgery	5 (10%)
ENT	1 (2%)

OBG contributed the highest number of cases (42%), followed by Neurosurgery (36%).

Table 4. Comparison of Intraoperative Cytology and Histopathology

Diagnosis	Intraoperative	Histopathology	Concordance (%)
Benign	23	22	95.7%
Malignant	25	25	100%
Inflammatory	1	2	50%
Tubercular	1	1	100%
Total	50	50	

Malignant and tubercular cases showed complete concordance.

Table 5. Diagnostic Performance of Intraoperative Cytology

Parameter	Value (%)
Sensitivity	96.15%
Specificity	95.83%
Positive Predictive Value (PPV)	96.15%
Negative Predictive Value (NPV)	95.83%
Overall Accuracy	96%

Intraoperative cytology demonstrated high sensitivity and specificity with excellent overall accuracy.

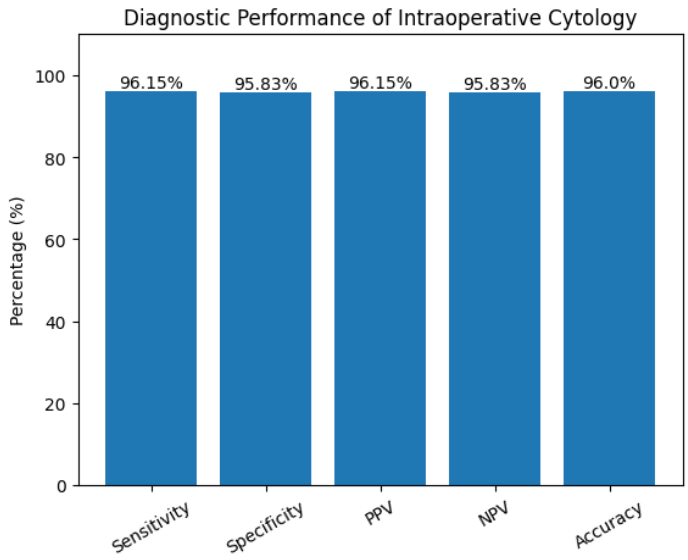

Figure 1: Diagnostic performance of intraoperative cytology in comparison with histopathology. The bar diagram illustrates sensitivity (96.15%), specificity (95.83%), positive predictive value (96.15%), negative predictive value (95.83%), and overall diagnostic accuracy (96%), demonstrating high concordance with the gold standard histopathological diagnosis.

Statistical Summary

In the present study of 50 cases, intraoperative cytology demonstrated a high degree of concordance with histopathological examination. Of the 25 malignant cases diagnosed on intraoperative cytology, all were confirmed on histopathology (100% concordance), while 22 of 23 benign cases were correctly categorized (95.7% concordance). One inflammatory case was underdiagnosed when compared with histopathology, accounting for the reduced concordance in this category. Overall, intraoperative cytology showed a sensitivity of 96.15% and specificity of 95.83%, with a positive predictive value of 96.15% and negative predictive value of 95.83%. The overall diagnostic accuracy was 96%, indicating excellent agreement with the gold standard histopathological diagnosis.

DISCUSSION

Intraoperative cytology (IOC), including squash, scrape, and imprint techniques, has emerged as an essential adjunct in surgical pathology, particularly in settings where rapid decision-making is required. In the present study, 50 cases were evaluated and correlated with histopathology, demonstrating an overall diagnostic accuracy of 96%, with sensitivity of 96.15% and specificity of 95.83%. These findings reaffirm the reliability of intraoperative cytology as a rapid diagnostic modality.

The majority of cases in the present study were females (82%), with the highest frequency observed in the 41–60 years age group (48%). This predominance reflects the significant contribution of Obstetrics and Gynecology cases (42%), particularly adnexal and ovarian specimens. Similar trends have been reported in studies evaluating intraoperative cytology in gynecological lesions, where rapid intraoperative diagnosis significantly influences surgical management [3,4].

Malignant lesions constituted 50% of cases in the present study. Notably, intraoperative cytology showed 100% concordance for malignant and tubercular cases when compared with histopathology. This high concordance highlights the ability of cytological techniques to accurately distinguish malignant from benign lesions during surgery. Comparable diagnostic accuracies ranging from 94% to 97% have been reported in previous studies evaluating intraoperative cytology and frozen section correlation [3,5].

Central nervous system (CNS) lesions formed a substantial proportion of cases (36%), and squash cytology was primarily employed in these cases. The technique demonstrated excellent diagnostic utility, particularly in gliomas and meningiomas. Squash cytology is especially suitable for CNS tumors because of the soft and friable nature of neural tissue, allowing optimal cellular preservation and nuclear detail visualization [7,8]. Jindal et al. reported an overall diagnostic accuracy of 94% in CNS lesions using squash smears [9], while Govindaraman et al. documented an accuracy of approximately 90% in intraoperative CNS consultation [10]. The findings of the present study are consistent with these reports, reinforcing the diagnostic strength of squash cytology in neurosurgical practice.

Scrape and imprint cytology were effectively utilized for epithelial and soft tissue lesions, particularly in ovarian, gastrointestinal, and lymph node specimens. Scrape cytology provides rapid assessment with minimal tissue loss and good preservation of cytomorphological features [1,5]. Imprint cytology, due to its simplicity and rapidity, has also been shown to be a valuable alternative to frozen sections in selected cases [6].

Despite the high overall accuracy, minor discordances were observed, particularly in inflammatory lesions. One inflammatory case was underdiagnosed intraoperatively when compared to histopathology. Such discrepancies may be attributed to sampling errors, tumor heterogeneity, overlapping cytological features, or paucicellular smears. Similar limitations have been acknowledged in previous studies [3,4]. Furthermore, intraoperative cytology cannot reliably assess depth of invasion or margin status, which remains a limitation when compared with frozen section and permanent histopathology.

The advantages of intraoperative cytology include rapid turnaround time (often within minutes), cost-effectiveness, minimal infrastructure requirement, and excellent cellular detail without freezing artifacts [3,4]. These features make it particularly valuable in resource-limited settings where frozen section facilities are unavailable. In the present study, the high sensitivity, specificity, and predictive values support its role as a dependable intraoperative diagnostic tool.

Overall, the strong concordance observed between intraoperative cytology and histopathology in this study emphasizes that IOC is not merely an adjunct but a highly reliable method for real-time surgical guidance. With appropriate

clinicoradiological correlation and experienced interpretation, intraoperative cytology can significantly improve surgical decision-making and patient outcomes.

CONCLUSION

The present study demonstrates that intraoperative cytology, including squash, scrape, and imprint techniques, is a rapid, reliable, and cost-effective diagnostic modality with high concordance to histopathology. With an overall diagnostic accuracy of 96%, and high sensitivity and specificity, intraoperative cytology proved highly effective in differentiating benign from malignant lesions across various anatomical sites.

Squash cytology showed particular utility in central nervous system lesions, while scrape and imprint techniques were valuable in gynecological and other soft tissue specimens. Although histopathology remains the gold standard for definitive diagnosis, intraoperative cytology plays a crucial role in real-time surgical decision-making, especially in resource-limited settings where frozen section facilities may not be available. When interpreted in conjunction with clinical and radiological findings, intraoperative cytology serves as a dependable adjunct that can significantly enhance surgical management and patient outcomes.

Clinical Implications

The findings of this study reinforce the practical utility of intraoperative cytology as a rapid and reliable diagnostic tool during surgical procedures. With high sensitivity and specificity, intraoperative cytology can effectively guide immediate surgical decisions such as extent of resection, need for additional sampling, and intraoperative management modifications. Its particular usefulness in central nervous system and gynecological lesions highlights its role in specialties where real-time diagnostic clarity significantly influences outcomes. In resource-limited settings where frozen section facilities are unavailable, intraoperative cytology serves as a cost-effective and dependable alternative, helping to reduce operative time, prevent unnecessary radical procedures, and potentially minimize the need for reoperation.

Limitations of the Study

Despite demonstrating high diagnostic accuracy, the present study has certain limitations. The sample size was relatively small (n = 50), which may limit the generalizability of the findings. Being a single-center study, institutional case distribution may have influenced the predominance of gynecological and neurosurgical specimens. Intraoperative cytology is inherently subject to sampling errors, tumor heterogeneity, and interpretative variability. Additionally, cytological techniques cannot reliably assess depth of invasion, architectural patterns, or margin status, which remain better evaluated on histopathology. Larger multicentric studies with subgroup analysis across different tumor types would further strengthen the evidence regarding the diagnostic efficacy of intraoperative cytology.

REFERENCES

1. Shidham VB, Dravid NV, Grover S, Kher AV. Role of scrape cytology in rapid intraoperative diagnosis: Value and limitations. Acta Cytol. 1984;28:477–82.
2. Mair S, Lash RH, Suskin D, Mendelsohn G. Intraoperative surgical specimen evaluation: Frozen section analysis, cytologic examination, or both? Am J Clin Pathol. 1991;96:8–14.
3. Scucchi LF, Di Stefano D, Cosentino L, Vecchione A. Value of cytology as an adjuvant intraoperative diagnostic method. Acta Cytol. 1997;41:1489–96.
4. Shidham VB, Gupta D, Galindo M, Haber M, Grotkowski C, Edmonds P, et al. Intraoperative scrape cytology: Comparison with frozen sections using receiver operating characteristic (ROC) curve. Diagn Cytopathol. 2000;23:134–9.
5. Sharma T, Singhal S, Kapoor N. Diagnostic utility and accuracy of scrape cytology in evaluation of neoplastic lesions. J Cytol. 2021;38(4):186–90.
6. Tribe CR. A comparison of rapid methods including imprint cytodiagnosis for the diagnosis of breast tumors. J Clin Pathol. 1973;26:273–7.
7. Eisenhardt L, Cushing H. Diagnosis of intracranial tumors by supravital technique. Am J Pathol. 1930;6:541–52.
8. Nanarng V, Jacob S, Mahapatra D, Mathew JE. Intraoperative diagnosis of central nervous system lesions: Comparison of squash smear, touch imprint, and frozen section. J Cytol. 2015;32(3):153–8.
9. Jindal A, Kaur K, Mathur K, Kumari V, Diwan H. Intraoperative squash smear cytology in CNS lesions: A study of 150 cases. J Cytol. 2017;34(4):217–22.
10. Govindaraman PK, Arumugam N, Ramasamy C, Prakasam G. Role of squash smear in intraoperative consultation of central nervous system tumors. J Sci Soc. 2017;44:7–14.