e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2026; 17(10); 74-84

Original Research Article

Problems Encountered in Squash Cytology Evaluation of Central Nervous System Lesions-Experience at Our Institution

Nandhini Selvarasu[1], Janani B.[2], Vysali P.[3]

[1]Assistant Professor, Department of Pathology, Arunai Medical College and Hospital, Tiruvannamalai, Tamilnadu, India. ORCID ID-0009-0003-2747-3860.
[2]Assistant Professor, Department of Pathology, Arunai Medical College and Hospital, Tiruvannamalai, Tamilnadu, India. ORCID ID-0009-0006-4567-5679.
[3]Assistant Professor, Department of Pathology, Arunai Medical College and Hospital, Tiruvannamalai, Tamilnadu, India. ORCID ID-0009-0005-0906-4398.

Received: 05-05-2026 / Revised: 23-08-2026 / Accepted: 15-10-2026
Corresponding Author: Dr. Janani B.
Conflict of interest: Nil

Abstract:

Background: Squash cytology is a rapid, cost-effective intraoperative diagnostic technique used for the evaluation of central nervous system (CNS) lesions. It provides valuable cytomorphological information to guide surgical decision-making. However, diagnostic interpretation may be affected by inadequate sampling, preparation artefacts, poor smearing and overlapping morphological features.

Aim: To identify the problems encountered during cytological evaluation and to assess the diagnostic accuracy of squash cytology in CNS lesions by comparing its findings with histopathological diagnosis.

Materials and Methods: This retrospective and prospective observational study was conducted in the Department of Pathology, Trichy SRM Hospital and Research Centre, over the period reported as June 2018 to June 2021. A total of 30 CNS lesion specimens submitted for squash cytology were included. Cytological smears were prepared, stained and evaluated for cellular morphology, arrangement and background characteristics. The cytological findings were compared with histopathological diagnoses. Technical and interpretative difficulties were also documented.

Results: Among the 30 patients, 17 (56.7%) were males and 13 (43.3%) were females. Space-occupying lesions constituted the most common clinical category, accounting for nine cases (30%). Squash cytology showed concordance with histopathology in 26 cases (86.67%), while four cases (13.33%) demonstrated discordance. The reported sensitivity was 92.86%, with an overall diagnostic accuracy of 86.67%. Technical or interpretative difficulties were encountered in six cases (20%). Inadequate material was the most frequent problem, occurring in two cases, while artefacts, confusing morphology, poor smearing and insufficient material during slide review accounted for the remaining difficulties.

Conclusion: Squash cytology is a useful intraoperative diagnostic method for CNS lesions. Careful sampling, proper smear preparation and correlation with histopathology are essential to improve diagnostic reliability.

Keywords: Squash Cytology; Central Nervous System Lesions; Intraoperative Diagnosis; Histopathology; Diagnostic Accuracy; Specimen Inadequacy; Cytological Artefacts.

DOI: 10.25258/ijpqa.17.10.12

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0) and the Budapest Open Access Initiative (http://www.budapestopenaccessinitiative.org/read), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Everything we do, every thought we have ever had, is produced by the human brain. But exactly how it operates remains one of the biggest unsolved mysteries, and it seems the more we probe its secrets, the more surprises we find. -Neil degrasse Tyson.

Brain is a major and key organ in the body. Integrating of all systems in our body is regulated by the brain. Brain plays an important coordinating system of our body. Vascular malformations, hamartomas, demyelinating disorders, congenital anomalies, inflammatory disorders, infections and tumours are the various space occupying lesions of brain. Among all tumours Central nervous system tumours occurs about 2% in children and adults. Next to leukaemia and other solid neoplasms, tumours of the central nervous system are the second most common tumours. 16.6% malignancy in childhood and adults are primarily central nervous system malignancies the world over.

Tumours of central nervous system occurs in 11.3% children and 26% in adults among Indian

population. According to epidemiology reports says Central nervous system tumours are increasing every year and more than 4000 new cases are diagnosed annually. Primary malignant tumours of central nervous system are seen in 5.8% per 1 lakh persons every year in males and 4.1per 1 Lakh persons per year in females in developing countries. Central nervous system tumours constitute the sixth most common form of tumours. In India mortality from Central nervous system tumours is about 4.5/1lakh among the general population.

The symptoms associated with malignant central nervous system tumour are very distressing to the patients which range from headache to paraparesis culminating in the death of the patients. Therefore, point of detection of central nervous system tumours becoming incurable is imperative and with narrow threshold point. The non-neoplastic lesions like tuberculoma, brain abscess, fungal abscess, and neurocysticercosis also should be diagnosed at early stage for potential cure of the patients since the delay in diagnosis will lead to irreversible neurological deficits.

Diseases in central nervous system cannot be identified with specific signs and symptoms. In all cases of central nervous system lesions integrated approach with neurophysicians, radiologist, neurosurgeon and pathologist is necessary to arrive at a specific diagnosis to treat the patient completely and effectively.

Advancement in neuroimaging techniques permits early and exact localization of tumour. Stereotactic biopsy of brain permits adequate sampling of multiple sites were by is essential and minute tissue sampling examination gives adequate pathology report at the earliest. The subsequent final diagnosis plays a key role for further treatment and for prognosis. Among all other technique, squash cytology provides better view of diseases which enables the surgeon to take immediate decision regarding surgical margin and closure.

The most important advantage of squash cytology is that cellular details cannot be affected by oedema, haemorrhage, necrosis or calcification and small bits of tissue is sufficient for squash technique to obtain a diagnosis. The important advantage of squash cytology is that fibrillary cytoplasm process is best demonstrated comparing with all other intraoperative technique.

Add on to this, few questionnaires asked to the consultant pathologist to know about the various problems encountered in squash cytology while evaluating the central nervous system be lesion. Various questions asked regarding1. Artifact 2. Sample inadequacy 3. Cases need respiration due in inadequacy and poor quality 4. Problem with smearing 5. Samples need mandatory histopathological evaluation to arrive a diagnosis.

The current study was undertaken to assess the diagnostic utility of squash cytology and to correlate with histopathological diagnosis and also to assess various problems encountered while evaluating the study.

Aim and Objective of the Study: To study the cytology of various CNS lesions by squash technique and identify the problems encountered during cytological evaluation and also to assess the diagnostic accuracy of squash cytology in CNS lesions by comparing its findings with histopathological diagnosis.

Materials and Method

This was a prospective and retrospective study performed in brain tissue received at the department of pathology, Trichy SRM Medical College Hospital and Research centre for a period of two years from June 2018 to June 2021 after getting ethical clearance. A total of 30 cases irrespective of age, sex and residence were included in this study. Details of the patient like age, sex, residence, height, weight, symptoms and signs on presentation, clinical diagnosis along with relevant clinical and radiological findings were collected; type of procedure done were collected from patient case files.

Procedure for Squash Cytology: Fresh tissue fragments obtained during surgery for suspected central nervous system lesions were selected for squash cytological examination. Representative tissue fragments were placed on clean glass slides and examined grossly using magnifying lens or dissecting microscope when required to assess their consistency and the presence of necrotic or haemorrhagic areas. Small fragments were gently compressed between two glass slides to obtain thin smears. The smears were fixed in 95% ethanol for 5 minutes and stained using haematoxylin and eosin and Giemsa stains as per the established laboratory protocol. The stained smears were examined microscopically for cellularity, cellular morphology, and patterns of cellular arrangement and background characteristics. Technical artefacts, specimen adequacy, smear quality and the presence of necrosis or haemorrhage were documented. The cytological diagnosis was subsequently correlated with the histopathological findings of the corresponding specimen.

The following set of questionnaires were asked to the reporting pathologist to assess the problems encountered in squash cytology while reporting the central nervous system lesion. The various questionnaires are

1. How many artifacts do you encountered while evaluation squash cytology?
2. No of sample do you feel inadequate while re-ceiving the slides?

3. No of samples with inadequate material and needs re – aspiration?
4. No of samples do you feel it is not smeared well?
5. No of samples do you feel histological architecture is not apparent in squash cytology evaluation
6. No of samples which shows inconclusive results in squash cytology

For histopathological examination, representative tissue samples were fixed in 10% neutral buffered formalin, processed routinely, embedded in paraffin and sectioned. The sections were stained with haematoxylin and eosin and evaluated by a pathologist. The final histopathological diagnosis was used as the reference for assessing the diagnostic accuracy of squash cytology.

Statistical Methods: All the data's were coded and entered in Microsoft excel sheet which was rechecked and analysed using statistical package for social sciences (spss) version16.

Results

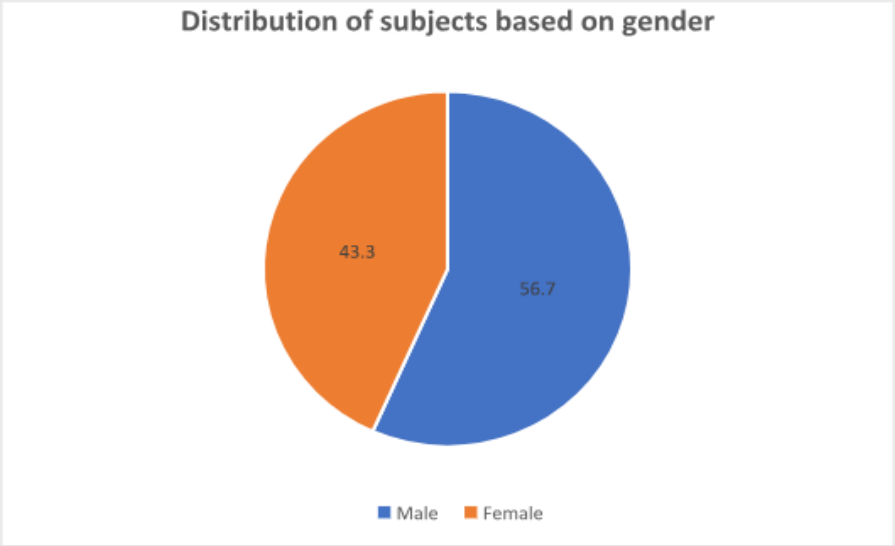


Figure 1: Distribution of subjects based on gender.

Figure 1 depicts the distribution of study subjects based on gender. Among the study participants 17 (56.7%) were male and 13 (43.3%) were female.

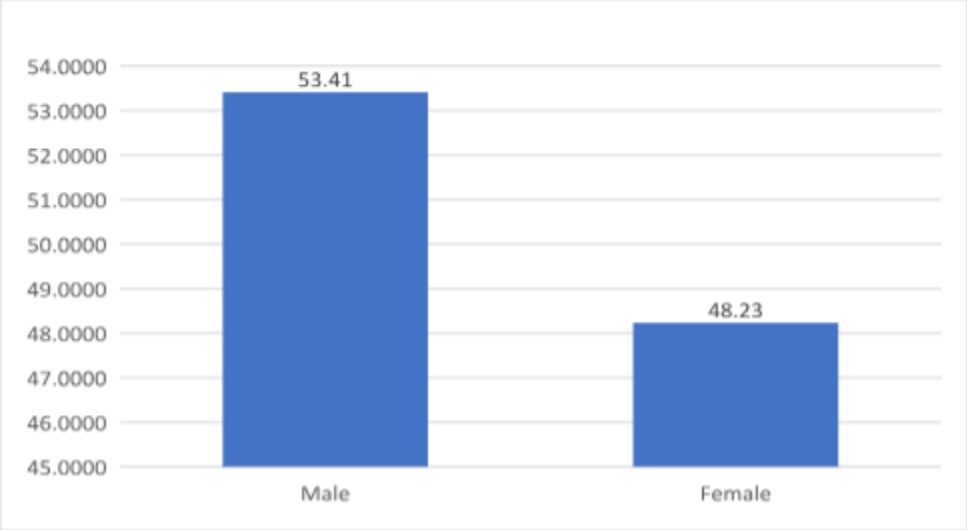


Figure 2: Distribution of subjects based on age.

Figure 2 depicts the distribution of subjects based on age. The average age of the male subjects was 53.41 and female was 48.23.

Table 1: Distribution of study subjects based on clinical diagnosis.

Clinical diagnosis	Number of cases	Percentage (%)
Craniopharyngioma	1	3.33
Paraspinal abscess/lumbar spondylosis	1	3.33
Left temporoparietal SOL	1	3.33
Backache (secondaries/malignant bony lesion)	2	6.67
Metastasis	2	6.67
Paraparesis	1	3.33
Giddiness	5	16.67
Headache	8	26.67
Space occupying tumor/Lesion	9	30.00

Table 1 depicts the distribution of study subjects based on clinical diagnosis. Most 9 (30%) of the subjects were clinically diagnosed with Space occupying tumour/Lesion, followed by headache 8 (26.67%), Giddiness 5 (16.67%), Backache (secondaries/malignant bony lesion) 2 (6.67%) and Metastasis 2 (6.67%), 1 (3.33%) with Craniopharyngioma, Paraspinal abscess/lumbar spondylosis 1 (3.33%), Left temporoparietal SOL 1 (3.33%) and Paraparesis 1(3.33%).

Table 2: Diagnostic accuracy of Squash cytology on comparison with histopathology

Diagnosis	Histopathology	Squash cytology	Accuracy %
Craniopharyngioma	1	1	100%
Granulomatous lesions	1	1	100%
Astrocytoma	2	2	100%
Neuroectodermal primitive tumor	1	1	100%
Metastasis from mucinous Adenocarcinoma	2	2	100%
Meningioma	9	8	88.8%
Schwannoma	8	9	88.8%
Lymphoplasmacytic infiltration	2	0	0%
Plasmacytoid lymphoma	0	2	0%
Fungal abscess	2	2	100%
High grade glioma	1	1	100%
Poorly differentiated carcinoma	1	0	0%
Anaplastic carcinoma	0	1	0%

Table 2 depicts the diagnostic accuracy of Squash cytology on comparison with histopathology. Out of 30 cases, 26 (86.67%) showed concordance and 4 (13.33%) showed discordance.

Table 3: Diagnostic accuracy of Squash cytology and histopathology on comparison with radiology report

Diagnosis	Radiology Report	Histopathol-ogy	Squash Cytol-ogy	Accu-racy %
Craniopharyngioma	1	1	1	100%
Paraspinal abscess	1	1	1	100%
Glioma	2	2	2	100%
Neuroectodermal primitive tumor	0	1	1	0%
Metastasis from mucinous adenocarcinoma	2	2	2	100%
Meningioma/schwannoma/space occupying lesion	20	17	17	85%
High grade glioma	2	1	1	50%
Lymphoplasmacytic infiltration.	1	2	0	50%
Plasmacytoid lymphoma	0	0	2	0%
Fungal abscess	0	2	2	0%
Backache secondary/malignant bony lesion	1	0	0	0%
Poorly differentiated carcinoma	0	1	0	0%
Anaplastic carcinoma	0	0	1	0%

Table 3 depicts the diagnostic accuracy of Squash cytology and histopathology on comparison with radiology report. Out of 30 cases, 20 (66.7%) showed concordance and 10 (33.3%) showed discordance for both squash cytology and histopathology. Although overall concordance was 66.67%, lesions such as Craniopharyngioma, Paraspinal abscess/lumbar spondylosis, Metastasis

and High-grade malignant neoplasm of glial origin showed 100% concordance.

Table 4: Sensitivity and specificity of Squash cytology

Tests		**Histopathology**		**Total**
Squash cytology	**Result**	**Positive**	**Negative**	
	Positive	26	2	28
	Negative	2	0	2
Total		28	2	30

Parameter	**Estimate**	**Lower - Upper 95% CIs**	**Method**
Sensitivity	92.86%	(77.35, 98.02)	Wilson Score
Specificity	0.00%	(0.0, 65.76)	Wilson Score
Positive Predictive Value	92.86%	(77.35, 98.02)	Wilson Score
Negative Predictive Value	0.00%	(0.0, 65.76)	Wilson Score
Diagnostic Accuracy	86.67%	(70.32, 94.69)	Wilson Score

Table 4 depicts the sensitivity and specificity of Squash cytology. The sensitivity is high at 92.86%. the specificity is 0 as there were no negative cases included in the study. The diagnostic accuracy is 86.67%.

Table 5: Difficulties and problems encountered during squash cytology

Problems or difficulties encountered in Squash cytology	**Number of cases**	**Percentage (%)**
Artifact	1	3.3
Inadequate material	2	6.8
Lesion with similar confusing morphology	1	3.3
Sample not smeared well	1	3.3
Insufficient sample while reviewing the slides	1	3.3

Table 5 shows the difficulties and problems encountered during squash cytology. Out of the 30 samples, problems were encountered with only 6 (20%) samples. The most common problem encountered was inadequate material 2 (6.8%). Other problems include Artifact 1(3.3%), Lesion with similar confusing morphology1 (3.3%), Sample not smeared well 1(3.3%) and Insufficient sample while reviewing the slides 1(3.3%).

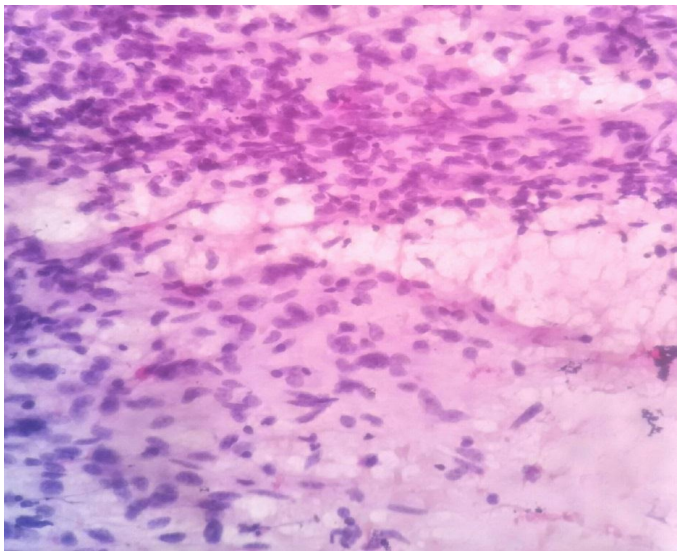


Figure 3: High grade glioma (F2669/19). Giemsa stain (10X)- Squash preparation shows sheets of neoplastic cells with high cellularity exhibiting moderate nuclear atypia.

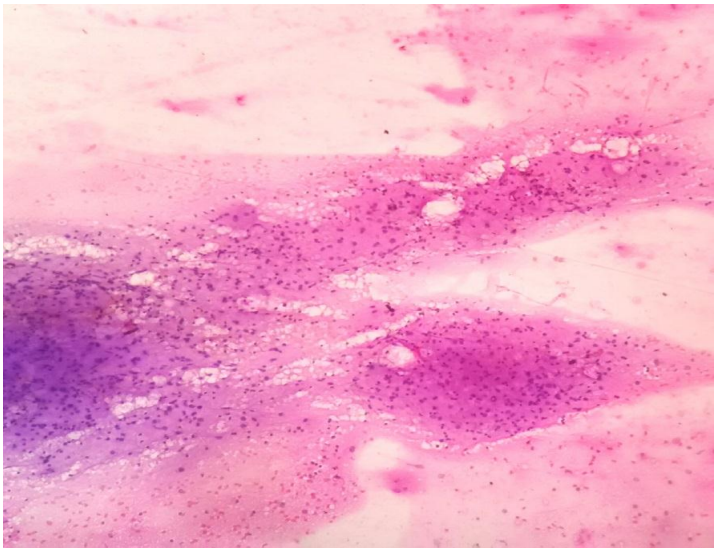


Figure 4: Low grade glioma (F1288/19). Hematoxyllin &Eosin stain (4X). Squash preparation shows sheets of reactive gliosis along with neoplastic cells

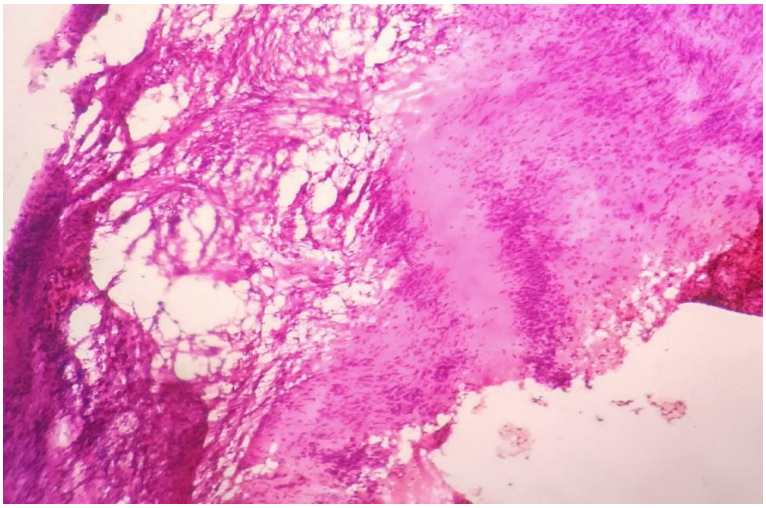


Figure 5: Schwannoma (F11/19). Squash preparation showing crushing artifact which resembles verocay bodies under H&E stain (10x).

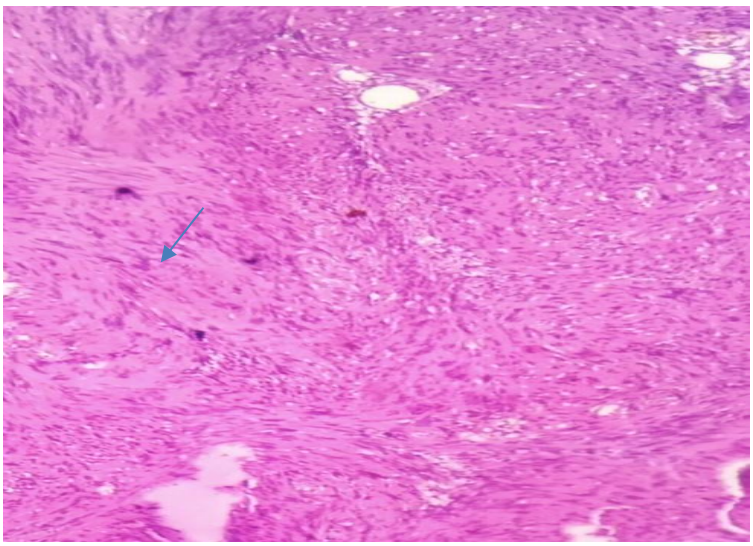


Figure 6: Schwannoma (H492/20) on low power(4X).Histopathology sections shows spindle cells in fascicles and bundles with verocay body formation(Arrow).

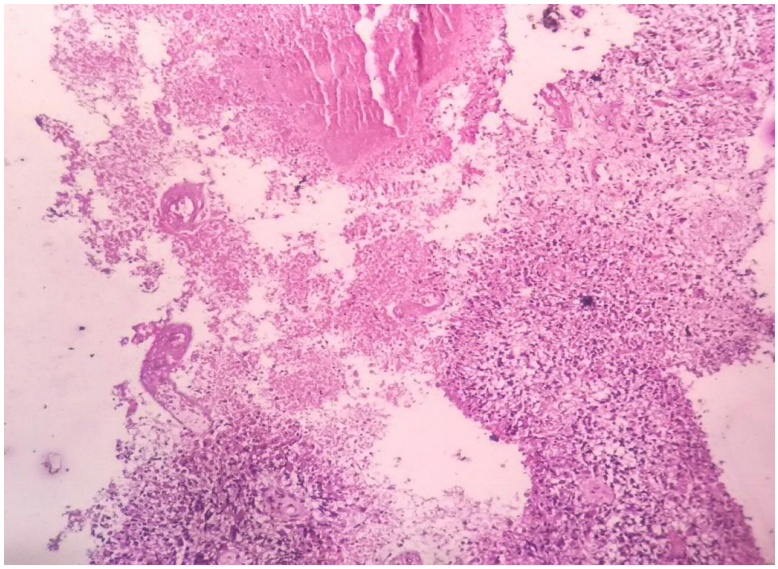


Figure 7: High grade glioma (H3169/18) on scanner view (4X) shows neoplastic cells with areas of necrosis

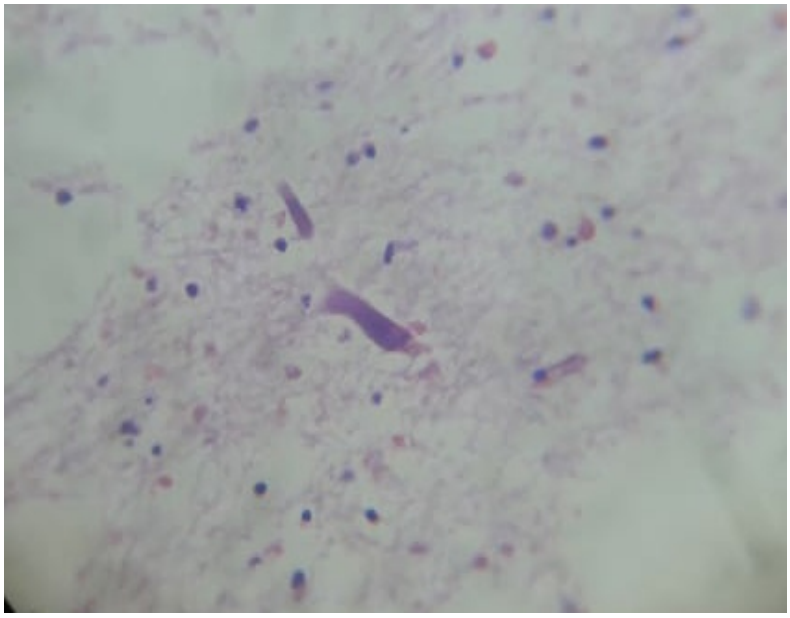


Figure 8: Fungal abscess (H6591/19): H&E(10X) Histopathology sections showing fungal hyphae

Discussion

Intraoperative squash cytology is an important diagnostic technique for the rapid evaluation of central nervous system (CNS) lesions. It provides immediate cytomorphological information during neurosurgical procedures and helps guide surgical decision-making while preserving tissue for definitive histopathological examination.

The technique is particularly useful because CNS tissue is generally soft and can be spread between two glass slides to demonstrate cellular morphology, nuclear characteristics, fibrillary processes and patterns of cellular arrangement. However, diagnostic interpretation may be affected by inadequate sampling, preparation artefacts, poor smearing, overlapping morphological features and the absence of tissue architecture. The present study, conducted at Trichy SRM Hospital and Research Centre, evaluated 30 CNS lesions to assess diagnostic concordance and identify practical difficulties encountered during squash cytology.

Demographic and Clinical Profile: In the present study, 17 patients (56.7%) were male and 13 (43.3%) were female, indicating a slight male predominance. The mean age was 53.41 years among males and 48.23 years among females. This distribution demonstrates that CNS lesions requiring intraoperative cytological evaluation occurred in both sexes, with a higher proportion of male patients in the study population. However, because the sample included only 30 cases, these demographic findings should be interpreted cautiously and cannot

establish a definitive association between sex and the occurrence of CNS lesions.

The clinical presentations were varied. Space-occupying tumours or lesions constituted the largest category, accounting for nine cases (30%), followed by headache in eight cases (26.67%) and giddiness in five cases (16.67%). Metastasis and backache associated with suspected secondary or malignant bone lesions accounted for two cases each (6.67%). Other presentations included craniopharyngioma, paraspinal abscess or lumbar spondylosis, left temporoparietal space-occupying lesion and paraparesis. These findings demonstrate the diversity of clinical presentations associated with lesions submitted for cytological evaluation.

The clinical manifestations of CNS lesions are often nonspecific, and similar symptoms may occur in neoplastic, inflammatory, infectious and other pathological conditions. Consequently, cytological findings must be interpreted alongside clinical history, neuroimaging and intraoperative observations. A multidisciplinary approach involving the neurosurgeon, radiologist and pathologist is essential for achieving an appropriate diagnosis and guiding subsequent management.

Diagnostic Concordance with Histopathology: In the present study, squash cytology showed concordance with histopathological diagnosis in 26 of the 30 cases (86.67%), whereas four cases (13.33%) demonstrated discordance. This finding indicates that squash cytology provided a correct diagnosis in most cases, although discrepancies remained in a clinically important minority. Histopathological examination remains essential for resolving these discrepancies and establishing the final diagnosis.

The diagnostic concordance observed in this study is comparable to the findings of several previous investigations. Mitra et al. reported a diagnostic accuracy of 88.5% for squash cytology in CNS tumours, supporting its usefulness as an intraoperative diagnostic method [1]. In a study involving 150 CNS space-occupying lesions, complete correlation with histopathology was observed in 141 cases, with two additional cases showing partial correlation and seven demonstrating discrepant findings; the overall diagnostic accuracy was 94% [2]. Krishnani et al. reported an overall accuracy of 94.9% when complete and partial agreement were considered, although complete agreement alone was lower [3]. These variations may reflect differences in sample size, lesion distribution, diagnostic criteria, technical preparation and the experience of the reporting pathologist.

Kumarguru et al. evaluated 50 CNS lesions and reported complete diagnostic concordance in 72% of cases, which increased to 90% when partial concordance was included [4]. Their findings highlight the importance of distinguishing complete diagnostic agreement from partial agreement, particularly when intraoperative cytology correctly identifies the general nature or origin of a lesion but cannot establish its precise subtype or grade.

The present study therefore supports the diagnostic value of squash cytology while emphasising that concordance depends on the criteria used to define a correct diagnosis. The manuscript should clearly specify whether the reported 86.67% represents complete diagnostic agreement or includes any category of partial agreement.

Sensitivity, Specificity and Diagnostic Interpretation: The sensitivity of squash cytology in the present study was reported as 92.86%, with an overall diagnostic accuracy of 86.67%. However, specificity was reported as zero because no negative cases were included in the study population. This is an important methodological consideration. Specificity cannot be meaningfully estimated when the study lacks an appropriate group of cases without the target condition. The reported value of zero should therefore not be interpreted as evidence that squash cytology has no ability to correctly identify negative cases.

Diagnostic performance must be assessed using a clearly defined target condition, such as the presence of a neoplastic lesion, and an appropriate two-by-two classification of true-positive, false-positive, true-negative and false-negative results. The absence of negative cases limits the interpretation of sensitivity and specificity and prevents a comprehensive assessment of the test's discriminatory ability.

In comparison, Krishnani et al. reported a sensitivity of 98.7% and specificity of 87.5% for the diagnosis of neoplastic lesions [3]. Another comparative study reported sensitivity, specificity and diagnostic accuracy of 90.6%, 87.5% and 89.3%, respectively, for squash cytology [5]. These results demonstrate that estimates of diagnostic performance depend on the inclusion of appropriate positive and negative categories and on the specific diagnostic question being investigated.

Accordingly, the sensitivity reported in the present study should be interpreted in the context of its small sample size and the case selection process. The results support further evaluation of squash cytology but do not independently establish its complete diagnostic performance across the entire spectrum of CNS lesions.

Problems Encountered During Squash Cytology: A major objective of the present study was to identify the technical and interpretative difficulties encountered during cytological evaluation. Problems were recorded in six of the 30 samples

(20%). Inadequate material was the most frequent difficulty, affecting two samples (reported as 6.8% in the manuscript). Other problems included preparation artefacts in one sample, confusing morphological similarities in one sample, inadequate smearing in one sample and insufficient material during slide review in one sample.

These findings emphasise that the quality of the final cytological interpretation depends substantially on the adequacy and representativeness of the specimen. A small biopsy may contain only a limited portion of the lesion, and this portion may not represent the most diagnostically informative area. Sampling error can therefore lead to an inconclusive diagnosis or disagreement with the final histopathological findings. Inadequate material may arise from limited tissue availability, particularly during stereotactic biopsy, or from sampling predominantly necrotic, haemorrhagic or nonrepresentative areas. Previous studies have similarly identified poor cellularity, nonrepresentative sampling, reactive cellular changes and morphological similarities as important causes of diagnostic error [4,6]. These observations suggest that specimen adequacy should be assessed before a definitive intraoperative interpretation is attempted.

When the initial material is insufficient, the neurosurgeon and pathologist should communicate promptly regarding the need for additional sampling, provided that further tissue acquisition is clinically appropriate and safe. Representative tissue should also be preserved for routine histopathology and any additional investigations required for definitive classification.

Smearing Technique and Preparation Artefacts: The squash technique depends on applying appropriate pressure to a small tissue fragment between two glass slides. Excessive pressure may cause crushing artefacts, distortion of nuclei and disruption of cellular relationships. Conversely, insufficient pressure may produce a thick, uneven smear with overlapping cells, making cytological interpretation difficult. These technical factors are particularly relevant in CNS specimens because the diagnostic appearance of cells and their processes may be altered by improper preparation.

In the present study, one sample was reported to have an artefact and another was inadequately smeared. Although these problems affected relatively few cases, they demonstrate that standardisation of the preparation technique is important. Small tissue fragments should be selected carefully, and the pressure applied during spreading should be sufficient to produce a thin, uniform smear without excessive cellular distortion. Previous research has demonstrated that squash preparation can provide useful diagnostic information when adequate cellular material is available and the smear is technically satisfactory [1,2]. Nevertheless, fibrous or collagen-rich tissue may resist spreading, while necrosis, haemorrhage and inflammatory changes can obscure the features needed for interpretation [4,6]. Thus, technical limitations should be recognised before morphological findings are used to support a definitive diagnosis.

Morphological Overlap and the Need for Histopathology: One sample in the present study showed confusing morphological similarities. This finding illustrates an important limitation of cytological diagnosis: different CNS lesions may exhibit overlapping cellular characteristics, particularly when only a small fragment is available for examination. Although the arrangement of cells, nuclear features, cytoplasmic characteristics and background material can suggest a particular lesion, these features may not always establish its precise identity.

The absence of preserved tissue architecture is another limitation. Squash cytology is valuable for demonstrating individual cells and fibrillary processes, but it cannot consistently reproduce the architectural relationships available in histological sections. This distinction is important when differentiating lesions with similar cytological appearances or when tumour classification and grading require additional morphological information.

Krishnani et al. observed better correlation in several common CNS tumours, including astrocytomas, meningiomas, schwannomas, medulloblastomas, pituitary adenomas and metastatic carcinomas, while discrepancies were more frequent in certain other tumour categories [3]. More recent work has likewise demonstrated that familiarity with cytomorphology, clinical information, radiological findings and the surgeon's intraoperative impression can help reduce interpretative errors [6].

The present study therefore reinforces the importance of correlating squash cytology with histopathological examination. When the cytological appearance is ambiguous, it is preferable to communicate the degree of diagnostic certainty and defer definitive classification until sufficient histological evidence is available rather than over interpret limited findings.

Clinical Implications and Study Limitations: The principal clinical advantage of squash cytology is the rapid availability of preliminary diagnostic information during surgery. A timely interpretation may assist the neurosurgeon in assessing the nature of a lesion and planning the immediate operative approach. Its relatively simple preparation and limited equipment requirements also make it useful in centres where frozen-section facilities are

unavailable or difficult to access. Nevertheless, the method should be regarded as complementary to, rather than a replacement for, histopathological examination [2,5].

The present study has several limitations. First, the sample size was small, comprising only 30 cases, which restricts the generalisability of the findings. Second, the inclusion of a selected population of lesions submitted for squash cytology may introduce selection bias. Third, the absence of negative cases limits the reliable estimation of specificity. Fourth, the study identified technical difficulties but did not provide a sufficiently large sample to determine statistically significant associations between individual problems and diagnostic discordance. Finally, the reported concordance with radiological findings should be distinguished from concordance with histopathology, because imaging provides a clinical-radiological impression rather than an independent histological reference standard.

Future studies involving larger prospective cohorts, standardised specimen preparation, clearly defined diagnostic categories and complete histopathological correlation would provide more reliable estimates of diagnostic performance. Recording the causes of discordance systematically and documenting the use of additional sampling or ancillary investigations could also help improve the quality of intraoperative diagnosis.

Conclusion

Squash cytology is a sensitive and specific modality for diagnosing space occupying lesions of brain and spinal cord. The method is easy, rapid and inexpensive. Details of cellular morphology are well seen in squash cytology. Hence squash cytology can be used as a reliable diagnostic tool in developing countries like India, since the cost of cryostat is prohibitive and unlike cryostat, squash cytology does not require any electricity for slide preparation. Moreover, cryostat needs an experienced microtomist to cut the sections and the problems of freezing artefacts cause diagnostic pitfalls. Despite the advantages, Squash cytology should be used as a preliminary investigation and should always be confirmed with Histopathology which is the golden standard. It should never be used solely for diagnostic or therapeutic.

References

1. Mitra S, Kumar M, Sharma V, Mukhopadhyay D. Squash preparation: a reliable diagnostic tool in the intraoperative diagnosis of central nervous system tumors. J Cytol. 2010;27(3): 81-85. doi:10.4103/0970-9371.71870.
2. Krishnani N, Kumari N, Behari S, Rana C, Gupta P. Intraoperative squash cytology: accuracy and impact on immediate surgical management of central nervous system tumours. Cytopathology. 2012;23(5):308-314. doi:10.1111/j.1365-2303.2011.00905.x.
3. Jaiswal S, Vij M, Jaiswal AK, Behari S. Intraoperative squash cytology of central nervous system lesions: a single centre study of 326 cases. Diagn Cytopathol. 2012;40(2):104-112. doi:10.1002/dc.21506.
4. 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):153-158. doi:10.4103/0970-9371.168835.
5. Kumarguru BN, Santhipriya G, Kranthi Kumar S, Ramesh Kumar R, Ramaswamy AS, Janakiraman P. A comparative study of squash smear cytology diagnosis and radiological diagnosis with histopathology in central nervous system lesions. J Cytol. 2022;39(1):1-8. doi: 10.4103/JOC.JOC_13_20.
6. Philip SA, Bai EL, Padmaja GJV, Kumari S. Analysis of intraoperative squash cytology of central nervous system lesions and its correlation with immunohistopathology and radiology. J Cytol. 2023;40(1):1-4. doi: 10.4103/joc.joc_70_22.
7. Folkerth RD. Smears and frozen sections in the intraoperative diagnosis of central nervous system lesions. Neurosurg Clin N Am. 1994;5(1): 1-18.
8. Cytopathology of the central nervous system. Part I. Utility of crush smear cytology in intraoperative diagnosis of central nervous system lesions. Ann Clin Lab Sci. 2001;31 (2):133-139.
9. Chen L, Zou X, Wang Y, Mao Y, Zhou L. Central nervous system tumors: a single center pathology review of 34,140 cases over 60 years. BMC Clin Pathol. 2013;13:14. doi:10.1186/1472-6890-13-14.
10. Dasgupta A, Gupta T, Jalali R. Indian data on central nervous tumors: a summary of published work. South Asian J Cancer. 2016;5(4):147-153. doi:10.4103/2278-330X.187589.
11. Eisenhardt L, Cushing H. Diagnosis of intracranial tumors by supravital technique. Am J Pathol. 1930;6(5):541-552.
12. Silverman JF, Timmons RL, Leonard JR 3rd, Hardy IM, Harris LS, O'Brien K, et al. Cytologic results of fine-needle aspiration biopsies of the central nervous system. Cancer. 1986;58(5):1117-1121.
13. Roessler K, Dietrich W, Kitz K. High diagnostic accuracy of cytologic smears of central nervous system tumors. Acta Cytol. 2002;46(4):667-674.
14. Folkerth RD. Smears and frozen sections in the intraoperative diagnosis of central nervous system lesions. Neurosurg Clin N Am. 1994;5(1):1-18.

15. 15. Gupta M, Pandey P, Aggarwal R, Faheem M. A comprehensive study on squash smear cytology with correlation to histomorphological and clinicoradiological findings in central nervous system lesions. Nat Resour Hum Health. 2026. doi:10.53365/nrfhh.2886.