

ROLE OF SQUASH CYTOLOGY IN CENTRAL NERVOUS SYSTEM TUMOURS: A HISTOPATHOLOGICAL CORRELATION STUDY

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ABSTRACT

Background: Central nervous system (CNS) tumours represent a diverse group of neoplasms that require timely and accurate diagnosis for appropriate surgical and therapeutic management. Intraoperative consultation is crucial in guiding the extent of resection and immediate decision-making. Frozen section is widely used but is limited by freezing artifacts and equipment requirements. Squash cytology offers a rapid, reliable, and cost-effective alternative, especially in resource-constrained settings. **Objective:** The present study was conducted to evaluate the diagnostic accuracy of squash cytology in CNS tumours and correlate the cytological features with histopathological diagnosis, which serves as the gold standard. **Materials and Methods:** This was a prospective study conducted in the Department of Pathology, Thanjavur Medical College and Hospital, from January 2014 to June 2016. Eighty-two neurosurgical specimens were received, of which 75 cases with adequate squash smears were included. Smears were prepared by gently pressing tissue fragments between glass slides, fixed in 95% ethanol, and stained with hematoxylin and eosin. Cytological diagnoses were compared with histopathology based on WHO 2007 classification of CNS tumours. Demographic details, tumour site, cytological findings, and cyto-histo correlation were analyzed. Statistical analysis was performed to calculate concordance, sensitivity, specificity, and diagnostic accuracy. **Result:** Patient ages ranged from 3 to 80 years (mean: 40 years), with peak incidence in the 31–40 years group. Female predominance was observed (M:F = 1:1.1). The most frequent sites were cerebrum (64%), posterior fossa (28%), sellar/suprasellar (4%), and spine (4%). Astrocytomas formed the largest group (26.7%), followed by meningiomas (24%) and schwannomas (18.6%). Of 75 cases, 68 showed complete concordance with histopathology, giving a diagnostic accuracy of 90.67%. Squash cytology was highly accurate in meningiomas, schwannomas, astrocytomas, glioblastomas, and ependymomas (accuracy 95–100%), whereas discordant diagnoses were observed in oligoastrocytomas, anaplastic medulloblastoma, hemangiopericytoma, and metastatic carcinomas. **Conclusion:** Squash cytology is a rapid, inexpensive, and reproducible diagnostic technique with high accuracy in most CNS tumours. It is particularly valuable in intraoperative settings where frozen section is unavailable. Challenges remain in mixed gliomas and metastatic tumours, underscoring the need for histopathology and ancillary techniques for definitive diagnosis.

INTRODUCTION

Primary central nervous system tumours constitute less than 2% of all adult cancers but are the second most common childhood malignancy after leukemia. The annual incidence of intracranial tumours is estimated at 10–17 per 100,000 persons. Timely intraoperative diagnosis is critical for neurosurgeons,

guiding the extent of resection, surgical approach, and immediate patient management.

Frozen section is considered the standard technique for intraoperative diagnosis, but it is limited by freezing artifacts, requirement for specialized equipment, and difficulty in interpretation due to the friable nature of CNS tissue. Squash cytology, first introduced by Eisenhardt and Cushing in 1930, emerged as a rapid and effective alternative. The soft and semi-solid consistency of most brain tumours

allows easy preparation of cytological smears with excellent preservation of cellular morphology. Furthermore, it requires minimal tissue (as small as 0.1 cm) and is particularly useful in stereotactic biopsies.

Several studies worldwide have demonstrated high diagnostic accuracy of squash cytology, ranging from 85% to 95%. However, variability is observed in specific tumour subtypes such as oligodendrogliomas, mixed gliomas, and metastatic carcinomas, where cytological features overlap. Given the limited number of comprehensive studies from India, this prospective study was conducted at a tertiary care centre to evaluate the diagnostic accuracy of squash cytology in CNS tumours, correlate cytological findings with histopathology, and identify the common sources of diagnostic errors.

MATERIALS AND METHODS

Study Design and Setting: This was a retrospective study conducted in the Department of Pathology, Thanjavur Medical College and Hospital, over a period of two and a half years (January 2014 – June 2016). Ethical approval was obtained from the institutional ethics committee.

Inclusion and Exclusion Criteria: All neurosurgical specimens received intraoperatively were included. Exclusion criteria were inadequate material for smear preparation and non-

representative samples. Of 82 cases received, 7 were excluded, leaving 75 cases for analysis.

Specimen Collection and Processing: Fresh unfixed tissue samples were obtained from the operating theatre. Small tissue fragments (1–2 mm) were placed on a glass slide and gently pressed with another slide to prepare smears. At least 5–6 smears were prepared per case. The smears were fixed in 95% ethanol and stained with rapid hematoxylin and eosin. Cytological examination was performed under light microscopy.

Histopathology: Formalin-fixed paraffin-embedded tissue sections were stained with H&E and classified according to the 2007 WHO classification of CNS tumours. Histopathology served as the gold standard.

Data Analysis: Concordance between squash cytology and histopathology was calculated. Accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were determined for the overall cohort and for major tumour subtypes.

RESULTS

Patient ages ranged from 3 to 80 years, with a mean age of 40 years. The majority of cases were in the 31–40 year age group (25.3%), followed by 41–50 years (17.3%). There was a slight female predominance (52%). The cerebrum was the most common site (64%), followed by cerebellopontine angle (28%), sellar/suprasellar (4%), and spinal (4%).

Table 1: Distribution of CNS Tumours

Tumour Type	Number of Cases
Low grade glioma	12
High grade glioma	11
Ependymoma	2
Medulloblastoma	3
Meningioma	18
Schwannoma	14
Craniopharyngioma	1
Pituitary adenoma	1
Metastatic adenocarcinoma deposits	4
Hemangioma	1
Hemangioblastoma	1
Olfactory neuroblastoma	1
Epidermoid cyst	1
Colloid cyst	1
Dermoid cyst	1
Tuberculoma	2
Abscess	1

Table 2: Age-wise Distribution

Age Group (years)	Number of Cases
<10	5
11–20	5
21–30	12
31–40	19
41–50	13
51–60	8
61–70	10
71–80	3

Table 3: Location of Tumours

Location	Number of Cases
Cerebrum	48
Cerebellopontine angle	21
Suprasellar	3
Spinal	3

Table 4: Correlation of Histopathology and Cytology

Tumour	Histology	Cytology	Discordant
Low grade glioma	12	12	0
High grade glioma	11	10	1
Ependymoma	2	2	0
Medulloblastoma	3	2	1
Meningioma	18	18	0
Schwannoma	14	14	0
Craniopharyngioma	1	1	0
Pituitary adenoma	1	1	0
Metastatic	4	2	2
Hemangioma	1	1	0
Hemangioendothelioma	1	0	1
Epidermoid	1	1	0
Dermoid	1	1	0
Colloid cyst	1	1	0
Olfactory neuroblastoma	1	1	0
Tuberculoma	2	2	0
Abscess	1	1	0

DISCUSSION

This study reinforces the value of squash cytology as a rapid intraoperative diagnostic tool with high accuracy (90.67%) for CNS tumours. Our findings are comparable to prior studies such as Jaiswal et al (83.7%), Roessler et al (89.8%), and Pawar et al (88%). The technique was particularly reliable for astrocytomas, glioblastomas, meningiomas, and schwannomas.

Challenges were encountered in mixed gliomas and metastatic tumours. In oligoastrocytomas, cytology often highlights one predominant component, leading to under-recognition of the mixed nature. Similarly, metastatic adenocarcinoma can mimic ependymoma or gemistocytic astrocytoma. These diagnostic pitfalls are well-documented in the literature.

Strengths of our study include its prospective design, adequate sample size, and use of WHO classification. Limitations include the single-centre setting, absence of immunocytochemistry or molecular studies, and small numbers for certain rare tumours. Future directions should focus on integrating cytology with immunocytochemistry, intraoperative squash imprint molecular assays, and digital pathology for enhanced accuracy.

Clinical Implications: In resource-limited settings where frozen section is not available, squash cytology provides an inexpensive, reliable, and reproducible diagnostic tool. With adequate training, it can serve as the primary intraoperative consultation modality for CNS tumours.

CONCLUSION

Squash cytology offers rapid and accurate intraoperative diagnosis of CNS tumours, with an overall accuracy of 90.67%. It is especially reliable in astrocytomas, glioblastomas, meningiomas, and schwannomas. Diagnostic limitations exist in mixed gliomas and metastatic tumours, underscoring the importance of correlation with histopathology and the need for adjunctive diagnostic techniques. The technique is simple, cost-effective, and particularly beneficial in neurosurgical centres without frozen section facilities.

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