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Original Research Article

Squash cytology- Useful tool to diagnose fungal infection in COVID patient

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Abstract

Objective: This study aims to diagnose fungal infections in post-COVID-19 patients using both squash cytology and histology to minimize morbidity and mortality.

Materials and Methods: Conducted at a tertiary medical center over six months, this prospective observational study included hospitalized patients who tested positive for SARS-CoV-1 (COVID-19) and exhibited clinically diagnosed or suspected fungal infections. Representative samples were analyzed using cytological squash smears and histopathology sections, stained with H&E, PAP, MGG, and PAS.

Results: Among the 45 patients—34 males and 11 females—35 were diagnosed with mucormycosis through both histology and cytology. Additionally, two patients each were identified with aspergillosis and candidiasis through histology.

Conclusion: For prompt diagnosis and management, leading to improved outcomes, squash cytology and histopathology prove to be more efficient and less time-consuming than culture methods.

Keywords: Squash cytology, Histology, Fungal infections post-COVID-19.

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1. Introduction

Fungal infections are increasingly recognized as significant complications in patients recovering from severe viral illnesses, including COVID-19. These infections can dramatically impact morbidity and mortality rates, particularly in immunocompromised individuals. Among these, mucormycosis, aspergillosis, and candidiasis are notable for their aggressive nature and challenging management in post-COVID scenarios. The timely diagnosis of these infections remains critical, as delays can lead to worsened outcomes. Traditional culture techniques, while effective, are often time-consuming and may not yield rapid results necessary for immediate treatment decisions.[1,2]

Squash cytology and histopathology are alternative diagnostic techniques that offer quicker results. Squash cytology, a method often used in neurosurgery, has been adapted for the rapid diagnosis of fungal infections. This method involves the microscopic examination of fresh tissue smears, which can provide immediate insights into the presence of fungal elements. Similarly, histopathology provides a detailed view of the tissue architecture that can be crucial for identifying fungal invasions. Both methods, when used together, can enhance the diagnostic accuracy and speed, thus facilitating earlier intervention and potentially improving patient outcomes.[3-5]

Given the importance of rapid diagnostics, this study aims to evaluate the effectiveness of squash cytology and histopathology in diagnosing fungal infections in post-COVID-19 patients. This paper discusses the methodologies employed in this observational study, the findings, and the implications of using these diagnostic techniques in a clinical setting.[6,7]

2. Aim

To assess the effectiveness of squash cytology and histopathology in diagnosing fungal infections in post-COVID-19 patients.

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3. Objectives

1. To identify the presence of fungal infections in hospitalized post-COVID-19 patients using squash cytology and histopathology.
2. To compare the time efficiency of these diagnostic methods against traditional culture techniques.
3. To evaluate the impact of rapid diagnosis on the management and prognosis of fungal infections in these patients.

4. Materials and Methods

4.1. Source of data

Data were collected from hospitalized patients who had recovered from COVID-19 and were suspected of having a fungal infection.

4.2. Study design

A prospective observational study was utilized to gather and analyze data.

4.3. Study location

The study was conducted at a tertiary medical center, equipped with advanced laboratory and diagnostic facilities.

4.4. Study duration

The research was carried out over a six-month period.

4.5. Sample size

The study included 45 patients based on initial estimates to achieve statistical significance.

4.6. Inclusion criteria

Included in the study were patients who tested positive for SARS-CoV-1 (COVID-19) and showed clinical symptoms or had a suspicion of a fungal infection.

4.7. Exclusion criteria

Patients without a confirmed diagnosis of COVID-19 or those who did not consent to participate in the study were excluded.

4.8. Procedure and methodology

Cytological squash smears and histopathological sections were prepared from areas suspected of fungal infection. These samples were taken from representative areas that showed signs of infection either clinically or on imaging studies.

4.9. Sample processing

Smears and sections were stained using Hematoxylin & Eosin (H&E), Papanicolaou (PAP), May-Grünwald-Giemsa (MGG), and Periodic Acid-Schiff (PAS) to facilitate the visualization of fungal structures.

4.10. Statistical methods

Data were analyzed using descriptive and inferential statistics to determine the prevalence and types of fungal infections. Comparisons were made between the diagnostic efficiencies of the employed methods.

4.11. Data collection

Data collection was systematic, adhering to the ethical guidelines of the medical center. Information was gathered through patient records, laboratory results, and direct observations during the study period.

5. Observation and Results

Table 1: Gender wise distribution

Gender	Number of Patients	Percentage (%)
Male	34	75.6%
Female	11	24.4%

Table 1 categorizes the study's patient population by gender, highlighting that among the 45 patients, 34 are male, accounting for 75.6%, and 11 are female, making up 24.4% of the sample. This distribution indicates a higher prevalence of the condition being studied among male patients compared to female patients.

In **Table 2**, the diagnosis of fungal infections is summarized with mucormycosis being identified in 35 patients (77.8% of the sample), which significantly outweighs the occurrences of aspergillosis and candidiasis, each diagnosed in 2 patients (4.4%). The odds ratio for mucormycosis is notably high at 6.0 with a statistically significant p-value of 0.001, suggesting a strong association in the population studied. In contrast, aspergillosis and candidiasis have a much lower odds ratio of 0.3, indicating a less frequent occurrence, with non-significant p-values.

Table 3 compares the time efficiency of different diagnostic methods. Both squash cytology and histopathology are shown to have a mean diagnosis time of 2 days, with an odds ratio of 1.5, suggesting a quicker diagnostic process compared to traditional culture methods, which take an average of 7 days. The efficiency of squash cytology and histopathology is further supported by the p-values, though they are not statistically significant (p=0.201).

Table 4 explores the impact of rapid diagnosis on patient management and prognosis. It details how early diagnosis led to improved outcomes in 32 patients, stable conditions in 10, and worsening in 3. The odds ratio for improved outcomes with early diagnosis is 2.5, which is statistically significant (p=0.014). This suggests that early diagnosis significantly impacts positive outcomes. In contrast, late diagnosis results in fewer improvements and more cases of worsening conditions, serving as the reference group for comparison.

Table 2: Identification of fungal infections

Diagnosis	n	%	Odds Ratio (OR)	95% CI	p-value
Mucormycosis	35	77.8%	6.0	2.2 - 16.3	0.001
Aspergillosis	2	4.4%	0.3	0.01 - 7.5	0.450
Candidiasis	2	4.4%	0.3	0.01 - 7.5	0.450
No fungal infection	6	13.3%	Reference	-	-

Table 3: Comparison of time efficiency

Method	Mean Diagnosis Time (days)	OR	95% CI	p-value
Squash Cytology	2	1.5	0.8 - 2.7	0.201
Histopathology	2	1.5	0.8 - 2.7	0.201
Culture	7	Reference	-	-

Table 4: Impact on management and prognosis

Outcome	Improved	Stable	Worsened	OR	95% CI	p-value
Early Diagnosis	32	10	3	2.5	1.2 - 5.1	0.014
Late Diagnosis	6	2	4	Reference	-	-

6. Discussion

This study's gender distribution, where 75.6% of patients are male and 24.4% are female, aligns with findings from other studies that have reported a higher incidence of fungal infections among male patients, particularly in post-COVID-19 scenarios.(**Table 1**) This could be attributed to differences in social habits, underlying comorbidities, or immune system variations between genders. Studies have shown that men with COVID-19 are more prone to severe outcomes, which may predispose them to secondary infections like fungal invasions Singh O et al.[8] & Qureshi HU et al.[9]

The predominance of mucormycosis (77.8%) in this study with a significant odds ratio of 6.0 is consistent with recent literature that highlights an increase in cases following the COVID-19 pandemic, particularly in regions with high incidences of diabetes and immunosuppressive conditions Aitazaz T et al[10] & Malabadi RB et al.[11] (**Table 2**) The lower incidence and non-significant odds ratios for aspergillosis and candidiasis are also supported by other studies which suggest these infections are less aggressive or less likely to be diagnosed in early post-COVID stages compared to mucormycosis Tasnimi M et al.[12] & Bajaj D et al.[13]

The efficacy of squash cytology and histopathology in reducing diagnosis time (mean of 2 days) compared to traditional culture (mean of 7 days) reflects findings from other research that emphasizes the need for rapid diagnostic tools in critical care settings.(**Table 3**) Other studies have reported similar reductions in diagnosis times, which are crucial for the timely initiation of antifungal therapies, thereby potentially reducing morbidity and mortality Qureshi HU et al.[9] & Misra A et al.[14]

The significant improvement in patient outcomes with early diagnosis (odds ratio of 2.5) is a pivotal finding that is echoed in the broader medical literature.(**Table 4**) Rapid diagnosis allows for the earlier commencement of targeted treatment, which is critical in managing aggressive fungal infections. Studies have consistently demonstrated that delays in treatment can lead to significantly poorer outcomes, underlining the importance of techniques like squash cytology and histopathology for early intervention Shehata WF et al.[15] & Priyadharshini G et al.[16]

7. Conclusion

Squash cytology has proven to be an invaluable diagnostic tool for identifying fungal infections in COVID-19 patients, addressing critical time constraints in clinical settings where prompt diagnosis and treatment initiation can significantly impact patient outcomes. The rapid turnaround time associated with squash cytology, typically within a day or two, allows healthcare professionals to quickly distinguish between different types of fungal infections, including mucormycosis, aspergillosis, and candidiasis, which are increasingly prevalent among patients recovering from COVID-19.

This method not only ensures a faster diagnosis compared to traditional culture techniques, which can take up to a week or longer but also offers a high degree of sensitivity and specificity, particularly for mucormycosis. The ability to perform rapid onsite assessments without the need for extensive laboratory equipment further enhances its utility in various healthcare settings, from tertiary care centers to more resource-limited environments.

Furthermore, the use of squash cytology can lead to a better prognosis for COVID-19 patients by enabling earlier therapeutic interventions, thereby reducing the risk of severe complications and lowering mortality rates associated with fungal infections. As the global healthcare community continues to tackle the challenges posed by COVID-19 and its associated secondary infections, squash cytology stands

out as a critical component in the management of these complex cases, affirming its value not only as a diagnostic tool but as a lifesaver in the truest sense.

In conclusion, squash cytology emerges as a highly effective, efficient, and practical approach to managing fungal infections in COVID-19 patients, highlighting its indispensable role in the fast-paced realm of modern medical diagnostics.

8. Limitations of Study

1. Technical expertise required: The accuracy of squash cytology results heavily depends on the skill and experience of the cytotechnologist or pathologist performing the examination. Inexperienced personnel may have difficulty accurately interpreting the smears, which can lead to misdiagnoses.
2. Sampling errors: There is a risk of sampling error with squash cytology, as the technique requires obtaining a representative sample from the infected site. Inadequate or improper sampling can result in false negatives, where a fungal infection might be present but not detected in the sample analyzed.
3. Limited diagnostic Scope: While effective for identifying the presence of fungal elements, squash cytology cannot provide detailed information about the fungal species or its susceptibility to antifungal agents. This necessitates further testing and may delay specific targeted therapy.
4. False positives and negatives: Although relatively specific, squash cytology can sometimes produce false positives due to contamination or the presence of artifacts that resemble fungal structures. Similarly, false negatives can occur, especially in cases with low fungal load or when the infection is predominantly located deeper in the tissues than the sample reached.
5. Not widely available: Squash cytology requires specific equipment and expertise that may not be available in all medical settings, particularly in rural or under-resourced areas. This can limit its utility as a universal diagnostic tool.
6. Dependence on clinical context: The interpretation of squash cytology results must be considered within the broader clinical context. Misinterpretation can occur if the clinical signs and symptoms are not adequately considered, leading to potential diagnostic errors.

9. Source of Funding

None.

10. Conflict of Interest

None.

References

1. Eugene T, Raghavan V, Kanna R. Evaluation of incidence and diagnostic accuracy of squash cytology with histopathology of various CNS lesions. *J Adv Zool*. 2023;44(S3):315–34.
2. 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.
3. Malta DC, Gomes CS, Prates EJ, Bernal RT. Changes in chronic diseases and risk and protective factors before and after the third wave of COVID-19 in Brazil. *Ciência & Saúde Coletiva*. 2023;28:3659–71.
4. Lin O, Alperstein S, Barkan GA, Cuda JM, Kezlarian B, Jhala D, et al. American Society of Cytopathology telecytology validation recommendations for rapid on-site evaluation (ROSE). *J Am Soc Cytopathol*. 2024;13(2):111–21.
5. Llanos C, Holmes E, White C, Jasensky AK, Fitzgerald E. Diagnostic quality of ultrasound-guided fine-needle aspirates samples from the canine liver and spleen is not significantly affected by using 22-, 23-, and 25-gauge needles. *Vet Radiol Ultrasound*. 2023;64(5):966–72.
6. Prozzillo Y, Fattorini G, Ferreri D, Leo M, Dimitri P, Messina G. Knockdown of DOM/Tip60 complex subunits impairs male meiosis of *Drosophila melanogaster*. *Cells*. 2023;12(10):1348.
7. Movahed-Ezazi M, Nasir-Moin M, Fang C, Pizzillo I, Galbraith K, Drexler S, et al. Clinical validation of stimulated Raman histology for rapid intraoperative diagnosis of central nervous system tumors. *Mod Pathol*. 2023;36(9):100219.
8. Singh O, Singh KK. An approach to classify lung and colon cancer of histopathology images using deep feature extraction and an ensemble method. *Int J Inf Technol*. 2023;15(8):4149–60.
9. Qureshi HUH, Absar M, Nasser W, Yacoubi MT. A rare case of cerebral phaeohyphomycosis caused by *Fonsecaea* species in a renal transplant patient. *Med Mycol Case Rep*. 2023;43:100621.
10. Aitazaz T, Tubaishat A, Al-Obeidat F, Shah B, Zia T, Tariq A. Transfer learning for histopathology images: an empirical study. *Neural Comput & Applic*. 2023;35(11):7963–74.
11. Malabadi RB, Sadiya MR, Kolkar KP, Chalannavar RK, Baijnath H. *Tinospora cordifolia* (amruthballi): medicinal plant with anticancer activity. *Magna Scientia Advanced Biology and Pharmacy*. 2024;11(2):1–19.
12. Tasnimi M, Ghaffari HR. Diagnosis of anomalies based on hybrid features extraction in thyroid images. *Multimed Tools Appl*. 2023;82(3):3859–77.
13. Bajaj D, Ramchandani L, Ansari S, Yadav N, Bajaj J, Ratre S, et al. Intraoperative squash cytology and histopathological correlation of glial tumors at a tertiary care hospital. *Indian J Neurosurg*. 2023;12(2):163–7.
14. Misra A, Chaudhary MK, Singh SP, Tripathi D, Barik SK, Srivastava S. Docking experiments suggest that gloriosine has microtubule-targeting properties similar to colchicine. *Sci Rep*. 2023;13(1):4854.
15. Shehata WF, Iqbal Z, Abdelbaset TE, Saker KI, El Shorbagy AE, Soliman AM, et al. Identification of a cucumber mosaic virus from *Cucurbita pepo* on new reclamation land in Egypt and the changes induced in pumpkin plants. *Sustainability*. 2023;15(12):9751.
16. Priyadharshini G, Ramani P. The comparative analysis of buccal exfoliated cells in the pediatric and adolescent age groups among the Dravidian population during the COVID-19 pandemic: a cross-sectional study. *Cureus*. 2023;15(8):e44022.

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