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Original Research Article

# Diagnostic Utility of Brush Cytology in the Evaluation of Oral Malignant and Premalignant Lesions in a Tertiary Care Setting

**Sonali Bandil[1], Nisha Chaudhary[2], Amit Kumar Yadav[3]**

[1]Associate Professor, Department of Pathology, Autonomous State Medical College, Firozabad, UP, India
[2]Associate Professor, Department of Microbiology, Autonomous State Medical College, Firozabad, UP, India
[3]Post Graduate, Department of Pathology, Autonomous State Medical College, Firozabad, UP, India

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**Corresponding author: Dr. Sonali Bandil**
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**Abstract**

**Background:** Early detection of oral malignant and potentially malignant lesions is essential to reduce morbidity and mortality associated with oral squamous cell carcinoma. Although histopathology remains the gold standard for diagnosis, it is invasive and may not always be feasible. Oral brush cytology has emerged as a non-invasive adjunctive diagnostic tool for early detection and screening.

**Objectives:** To evaluate the utility of brush cytology in the screening and early diagnosis of oral malignant and premalignant lesions and to correlate cytological findings with histopathological diagnosis.

**Materials and Methods:** A total of 76 patients with clinically suspected oral malignant and premalignant lesions were included. Buccal mucosal scrapings were obtained using the brush technique, followed by punch biopsy from the same lesion. Cytological findings were correlated with histopathological diagnosis, which was considered the gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated.

**Results:** Out of 76 cases, 43 were confirmed malignant on histopathology. Brush cytology correctly identified 37 true positive and 33 true negative cases, with 6 false negative and no false positive cases. The sensitivity and specificity were 86% and 100%, respectively. The positive predictive value was 100%, negative predictive value was 84.6%, and overall diagnostic accuracy was 92.1%.

**Conclusion:** Oral brush cytology is a simple, cost-effective, and non-invasive adjunctive diagnostic tool with high specificity and good sensitivity. It is particularly useful for screening and early detection of oral malignant and premalignant lesions, especially in resource-limited settings.

**Keywords:** Diagnostic Utility, Brush Cytology, Oral Malignant, Premalignant Lesions.

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## Introduction

Oral cancer remains a significant global health challenge, ranking among the most common malignancies worldwide, with particularly high incidence and mortality in South-East Asia and India due to prevalent tobacco use, betel quid chewing, and alcohol consumption. [1]

Oral squamous cell carcinoma (OSCC), the predominant histological subtype, often arises from clinically identifiable premalignant lesions such as leukoplakia, erythroplakia, and oral submucous fibrosis, highlighting the critical need for early and accurate diagnosis to improve clinical outcomes and survival rates. [2] Early detection of malignant and potentially malignant disorders (PMDs) facilitates timely intervention and can substantially reduce morbidity and healthcare burdens, particularly in resource-limited tertiary care settings. Histopathological examination of scalpel biopsies remains the gold standard for diagnosing oral malignancies and grading dysplasia in PMDs. However, this technique has limitations, including invasiveness, patient discomfort, risk of complications, and logistic challenges in high-volume clinical environments. [3] These constraints often deter patients from undergoing biopsy, leading to diagnostic delays and late-stage presentations, which are associated with poorer prognoses. Consequently, there has been significant interest in developing adjunctive, minimally invasive diagnostic tools that can efficiently screen suspicious oral lesions and guide clinical decision-making.

Exfoliative cytology, particularly brush cytology, has emerged as a promising non-invasive alternative capable of sampling epithelial cells from all layers of the mucosal surface. [4] Brush cytology involves the use of a cytology brush or similar instrument to acquire transepithelial cell samples, which are then evaluated cytologically for dysplastic and neoplastic features. Multiple studies have demonstrated that brush cytology can detect cellular atypia and malignant changes with reasonably high specificity and variable sensitivity, suggesting its potential role as a first-level diagnostic tool or a screening method prior to biopsy. [5-7]

The development of advanced techniques such as liquid-based cytology (LBC) and computer-assisted analysis (e.g., OralCDx has further improved the clarity and diagnostic yield of brush cytology samples, although cost and availability remain barriers in many settings. [8,9] In this context, assessing the diagnostic accuracy and practical utility of brush cytology for oral malignant and premalignant lesions is imperative. By comparing cytological findings with conventional histopathology, clinicians and researchers can define the role of brush cytology as a screening tool, diagnostic adjunct, or triage method that may reduce unnecessary biopsies and facilitate early detection. With this background, the study aims to evaluate the diagnostic performance of oral brush cytology in patients presenting with clinically suspicious oral lesions in a tertiary care setting.

## Material & Methods

**Study Setting & Design:** A cross-sectional descriptive study was carried out over a period of six months in the Cytology and Histopathology sections of the Department of Pathology, in collaboration with the Department of Dentistry, at a tertiary care teaching hospital to evaluate the diagnostic utility of oral brush cytology in patients with clinically suspected oral malignant and premalignant lesions, with histopathology taken as the gold standard.

**Study Population:** The study included patients attending the outpatient department of Dentistry who were clinically suspected to have oral malignant or premalignant lesions. A total of 76 patients with clinically suspicious oral lesions were enrolled in the study based on convenient sampling technique.

### Inclusion Criteria

- Patients presenting with clinically suspected oral premalignant lesions (such as leukoplakia, erythroplakia, oral submucous fibrosis)
- Patients with clinically suspected oral malignant lesions
- Patients willing to give informed consent for both brush cytology and biopsy

### Exclusion Criteria

- Previously diagnosed cases of oral malignancy
- Patients who had received prior treatment such as surgery, chemotherapy, or radiotherapy for oral lesions
- Patients unwilling to undergo biopsy or brush cytology
- Poor or inadequate cytological samples

### Sample Collection Procedure

### Oral Brush Cytology

- Buccal mucosal scrapings were obtained using a cytology brush.
- The lesion was brushed with moderate pressure until pinpoint bleeding was observed, ensuring transepithelial sampling.
- The collected material was immediately smeared onto clean glass slides.
- The slides were fixed in 95% ethanol and subsequently stained using Papanicolaou (Pap) stain.
- Cytological evaluation was performed by experienced pathologists and categorized as:
    - Negative for malignancy
    - Atypical / suspicious
    - Positive for malignancy

### Histopathological Examination

- Punch biopsy specimens were obtained from the same lesion site after brush cytology.
- Biopsy tissues were fixed in 10% neutral buffered formalin.
- Routine tissue processing was done, and hematoxylin and eosin (H&E) stained sections were examined.
- Histopathological diagnosis was considered the gold standard and lesions were categorized as:
    - Benign
    - Premalignant (with or without dysplasia)
    - Malignant

### Correlation of Findings

- Cytological findings were correlated with histopathological diagnosis for confirmation.
- Both cytological and histopathological findings were also correlated with clinical diagnosis.

**Statistical Analysis:** Statistical analysis was performed to assess the diagnostic utility of oral brush cytology.

- **Sensitivity and specificity** were calculated using histopathology as the reference standard.

- Diagnostic validity was assessed using the following definitions:
  - **True Positive (TP):** Samples positive on both histology and brush cytology
  - **True Negative (TN):** Samples negative on both histology and brush cytology
  - **False Positive (FP):** Samples negative on histology but positive on brush cytology
  - **False Negative (FN):** Samples positive on histology but negative on brush cytology

**Results**

A total of 76 patients with clinically suspected oral malignant and premalignant lesions were included in the study. All patients underwent brush cytology followed by punch biopsy for histopathological confirmation.

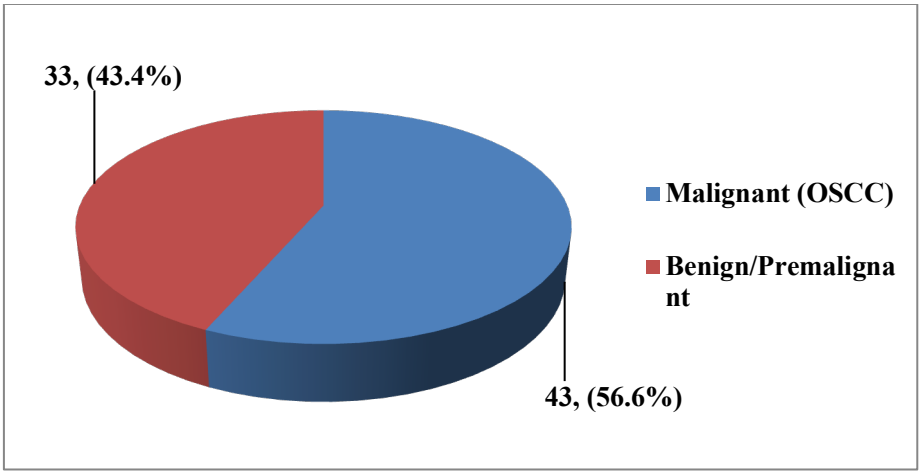


**Figure 1: Distribution of study subjects based on Histopathological Diagnosis of Oral Cavity Lesions (n = 76)**

Out of 76 cases:

- 43* cases (56.6%) were confirmed as malignant (OSCC) while 33 cases (43.4%) were benign/premalignant.
- (*Including 37 cytology-positive malignant cases and 6 suspicious cases confirmed malignant on histology.)

**Table 1: Comparison of Histopathological and Brush Cytology Diagnosis**

| Brush Cytology | Histopathology Malignant | Histopathology Benign | Total |
|---|---|---|---|
| **Positive** | 37 (TP) | 0 (FP) | 37 |
| **Negative** | 6 (FN) | 33 (TN) | 39 |
| **Total** | **43** | **33** | **76** |

Out of 76 cases:

- 37 cases were positive for malignancy on both brush cytology and histopathology (True Positives).
- 6 cases were reported as suspicious on cytology but confirmed malignant on histopathology (False Negatives for strict positive category).
- 33 cases were negative for malignancy on both cytology and histopathology (True Negatives).
- No false positive cases were reported.

**Table 2: Comparison of Clinical and Histopathological Diagnosis**

| Clinical Diagnosis | Histopathology Malignant | Histopathology Benign | Total |
|---|---|---|---|
| **Clinically malignant** | 40 | 3 | 43 |
| **Clinically premalignant** | 3 | 30 | 33 |
| **Total** | **43** | **33** | **76** |

**Table 3: Comparison of Clinical Diagnosis with Brush Cytology**

| Clinical Diagnosis | Cytology Positive | Cytology Negative | Total |
|---|---|---|---|
| **Clinically malignant** | 35 | 8 | 43 |
| **Clinically premalignant** | 2 | 31 | 33 |
| **Total** | **37** | **39** | **76** |

Using histopathology as the gold standard:

- True Positive (TP) = 37 **&** True Negative (TN) = 33

- False Positive (FP) = 0 **&** False Negative (FN) = 6

Therefore:

- Sensitivity = TP / (TP + FN) × 100 = 37 / (37 + 6) × 100 = 86.0%
- Specificity = TN / (TN + FP) × 100 = 33 / (33 + 0) × 100 = 100%
- Positive Predictive Value (PPV) = 100%
- Negative Predictive Value (NPV) = 84.6%
- Diagnostic Accuracy = (TP + TN) / Total × 100 = (37 + 33) / 76 × 100 = 92.1%

**Table 5: Diagnostic Validity of Oral Brush Cytology**

| Parameter | Value (%) |
|---|---|
| **Sensitivity** | 86.0% |
| **Specificity** | 100% |
| **Positive Predictive Value** | 100% |
| **Negative Predictive Value** | 84.6% |
| **Diagnostic Accuracy** | 92.1% |

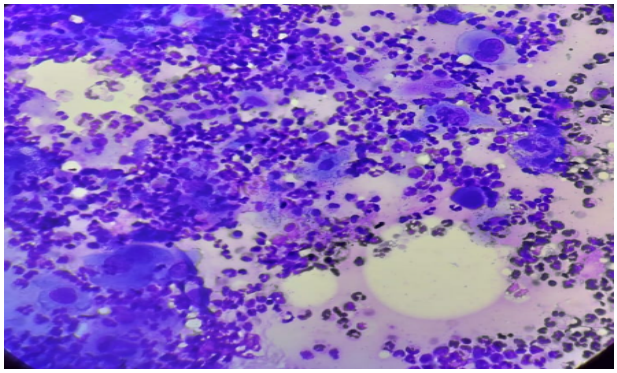

**Figure 2: High power view showing malignant squamous cells with increased nuclear-cytoplasmic ratio, hyperchromasia, and irregular nuclear membranes on brush cytology (Pap stain)**

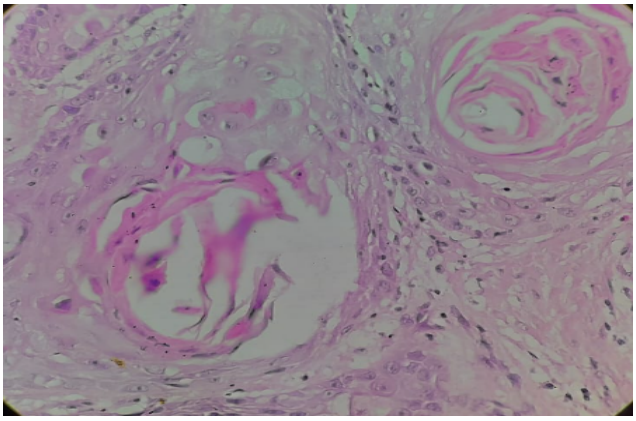

**Figure 3: Histopathological section showing keratin pearls suggestive of well-differentiated squamous cell carcinoma (H&E stain)**

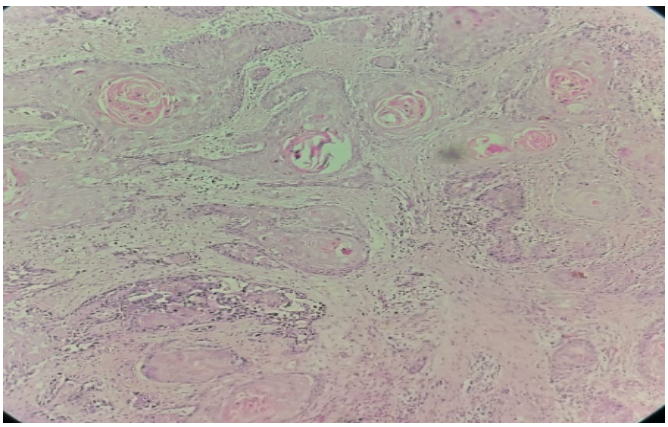

**Figure 4: Low power view showing sheets of malignant squamous cells with keratin pearl formation**

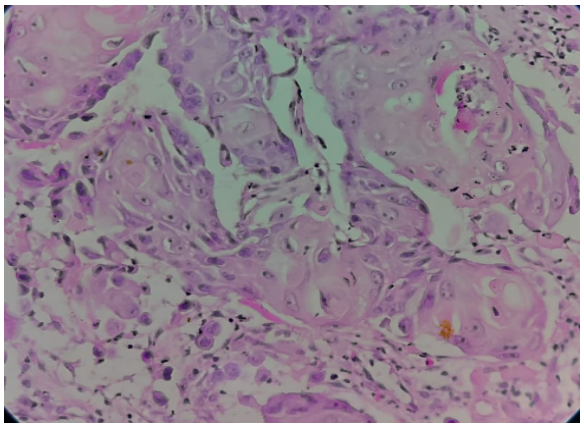

**Figure 5: High power view showing invasive malignant squamous cells with nuclear pleomorphism and mitotic figures**

## Discussion

The study demonstrated high specificity (100%) and good sensitivity (86%), with a diagnostic accuracy of 92.1%. These findings support the growing body of evidence suggesting that brush cytology is a valuable adjunctive diagnostic tool in oral lesion evaluation.

The high specificity observed in our study indicates that brush cytology is highly reliable in identifying true negative cases, reducing the risk of over-treatment in benign conditions. Similar findings have been reported in other studies where specificity frequently exceeds 90% in cytological assessments of oral lesions. A cost-utility analysis involving 284 patients reported specificity of nearly 95% using liquid-based brush cytology, indicating that cytological techniques can reliably exclude malignant pathology in most cases. [3] The 100% positive predictive value in our series highlights that cytology-positive results were always confirmed by histopathology, reaffirming its strength in confirming malignancy.

Our sensitivity of 86% is comparable with recent literature. A large meta-analysis examining cytological methods, including brush cytology for early detection of OSCC and potentially malignant disorders, reported pooled sensitivity around 91% and specificity near 96%. [10] This meta-analytic evidence supports the use of cytology as an adjunct screening modality, though it still falls short of replacing biopsy as the diagnostic gold standard. Our sensitivity aligns with these pooled estimates, reinforcing the clinical relevance of cytology in high-risk populations.

Previous individual studies also corroborate our findings. For example, an observational study done by Castillo P, et al. in 2022 [11] reported sensitivity and specificity values approaching 88% and 100% respectively for liquid-based brush cytology in oral carcinoma detection before treatment. Systematic review done by Walsh T et al in 2021 [12] similarly describe brush cytology as a moderately reliable screening tool, especially for high-grade dysplasia, with some variability depending on study design and lesion type.

Brush cytology's non-invasive nature and potential for repeated sampling make it particularly valuable in screening and monitoring populations with oral potentially malignant disorders (OPMDs). Patients often prefer this technique due to reduced discomfort compared to scalpel biopsy, and it may improve compliance with follow-up protocols. A recent clinical study done by Subba S et al [13] highlighted improved patient acceptance and compliance rates for non-invasive techniques including brush biopsy over invasive procedures, highlighting its usefulness in routine practice also.

Emerging techniques that combine brush cytology with molecular markers or immunocytochemistry are promising. For example, adding p16 immunocytochemical assessment has been shown to increase diagnostic performance in cytological specimens, providing more detailed biological insights and potentially improving sensitivity. [7] Additionally, advancements such as computational analysis and standardized cytology classification systems can further enhance diagnostic accuracy and interobserver consistency.

## Recommendations

1. **Use as a Screening Tool**: Oral brush cytology should be utilized as a first-line screening method for clinically suspicious oral lesions, particularly in high-risk populations.
2. **Adjunct to Histopathology**: It should be considered an adjunctive diagnostic tool rather than a replacement for biopsy.
3. **Application in Resource-Limited Settings**: The indigenous brush technique (toothbrush method) can be implemented in peripheral health centers due to its cost-effectiveness and ease of performance.

4. **Repeat Sampling for Suspicious Lesions**: In cases with negative cytology but strong clinical suspicion, repeat cytology or biopsy should be performed.

**Limitations**

1. **Small Sample Size & Single-Center Study**: The study included only 76 cases, which may limit the generalizability of the findings & being conducted at a single tertiary care center, results may not represent the broader population.
2. **Sampling Error**: False negative cases (6 cases) may be attributed to inadequate transepithelial sampling or deeper invasive lesions not reflected in superficial exfoliated cells.
3. **Lack of Subclassification of Dysplasia**: Premalignant lesions were not graded into mild, moderate, or severe dysplasia cytologically, which may affect detailed comparative analysis.

**Conclusion**

The present study demonstrates that oral brush cytology is a simple, non-invasive, cost-effective, and reliable adjunctive diagnostic tool for evaluating oral malignant and premalignant lesions.

With high specificity (100%) and good sensitivity (86%), it shows strong diagnostic accuracy when correlated with histopathology. Although it cannot replace biopsy as the gold standard, brush cytology serves as an effective screening and triage method, particularly in resource-limited settings, facilitating early detection and improving patient compliance and outcomes.

**References**

1. Alsarraf AH, Kujan O, Farah CS. The utility of oral brush cytology in early detection of oral cancer and oral potentially malignant disorders: systematic review. J Oral Pathol Med. 2018;47(2):104-116.
2. Babshet M, Nandimath K, Pervatikar SK, Naikmasur VG. Efficacy of oral brush cytology in the evaluation of oral premalignant and malignant lesions. J Cytol. 2011;28(4):165-172.
3. Oral brush biopsy using liquid-based cytology is a reliable tool for oral cancer screening: A cost-utility analysis. PubMed. 2023;35704619.
4. Alsarraf AH, Kujan O, Farah CS. The utility of oral brush cytology in the early detection of oral cancer and oral potentially malignant disorders: a systematic review. J Oral Pathol Med. 2018;47(2):104-116.
5. Babshet M, Nandimath K, Pervatikar SK, Naikmasur VG. Efficacy of oral brush cytology in the evaluation of oral premalignant and malignant lesions. J Cytol. 2011;28(4):165-172.
6. Sharma S, V A, Saxena HB. Efficacy of oral brush cytology in detection of oral malignant and premalignant lesions. Natl J Integr Res Med. 2018;9(6):13-17.
7. Gure PK, Das U, Haque M, Goswami BK. Brush cytology on pre-malignant and malignant oral lesions with histopathological correlation. Bengal J Otolaryngol Head Neck Surg. 2023;30(2).
8. Alsarraf AH, Kujan O, Farah CS. The utility of oral brush cytology in the early detection of oral cancer and oral potentially malignant disorders: a systematic review. J Oral Pathol Med. 2018;47(2):104-116.
9. Mehrotra R, Gupta A, Singh M, Ibrahim R. Efficacy of oral brush biopsy with computer-assisted analysis in the evaluation of oral lesions. Head Neck Oncol. 2011; 3:39.
10. Tayebi-Hillali H, et al. Accuracy of cytological methods: systematic review. J Oral Pathol Med. 2025.
11. Castillo P, et al. Liquid-based brush cytology for carcinoma diagnosis. Clin Oral Investig. 2022.
12. Walsh T, Macey R, Kerr AR, Lingen MW, Ogden GR, Warnakulasuriya S. Diagnostic tests for oral cancer and potentially malignant disorders in patients presenting with clinically evident lesions. Cochrane Database Syst Rev. 2021;7:CD010276.
13. Subba S, Das C, Mukhopadhyay M. Brush Cytology with p16 Immunocytochemistry in Oral Lesions. Adv Med Sci. 2024; 4:172-186.