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Original Article

Diagnostic Role of Fine Needle Aspiration Cytology (FNAC) in Oral and Maxillofacial Masses: A Descriptive Cross-Sectional Study

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ABSTRACT

Oral and maxillofacial swellings comprise a wide spectrum of inflammatory, benign, and malignant conditions that often present with overlapping clinical and radiological features. **Objectives:** To determine the diagnostic accuracy of fine needle aspiration cytology in oral and maxillofacial swellings using histopathology as the reference standard. **Methods:** The research is a descriptive cross-sectional study that was undertaken at the Department of Oral and Maxillofacial Surgery, Jinnah Post-Graduate Medical Centre, Karachi, within a period of four months from December 2025 to March 2026, after receiving the consent of the IRB. Non-probability consecutive sampling was used to select a total of 139 adult patients who had palpable oral and maxillofacial swellings. FNAC was done in aseptic conditions, and cytological results were compared to histopathology, which was taken as the reference standard. The results of FNAC were compared to the histopathological results based on a 2x2 contingency table. **Results:** A total of 139 patients with oral and maxillofacial swellings were analyzed, predominantly middle-aged males from urban areas, with most lesions present for ≤6 months. FNAC showed strong diagnostic performance against histopathology, with overall sensitivity of 89.7%, specificity of 93.0%, and diagnostic accuracy of 91.4%. Performance was highest in inflammatory lesions, followed by malignant and benign lesions. Cytological features showed typical biphasic epithelial and myoepithelial patterns without malignancy in benign cases, supporting FNAC as a reliable diagnostic tool. **Conclusions:** Fine needle aspiration cytology is a reliable first-line diagnostic tool for oral and maxillofacial swellings, demonstrating high accuracy in distinguishing inflammatory, benign, and malignant lesions.

INTRODUCTION

Fine needle aspiration cytology (FNAC) is a non-invasive, fast, and cheap diagnostic method that is broadly utilized in the assessment of oral and maxillofacial masses, especially those of the salivary glands. It is important in preoperative diagnosis, and it aids clinicians in distinguishing between benign and malignant lesions and the management strategies. FNAC is a reliable first-line diagnostic tool, demonstrated by Afzal *et al.* who showed that FNAC had a high diagnostic accuracy when used in diagnosing lesions of the salivary glands when compared to histopathology [1]. Likewise, Ramzan *et al.* also found that the FNAC increased the diagnostic accuracy and clinical outcome in parotid gland masses when used as a component of the diagnostic workup [2]. The diagnostic usefulness of FNAC has also been increased with the introduction of standardized reporting systems. Hamid *et al.* emphasized the significance of cyto-histological correlation with the Milan System of Reporting Salivary Gland Cytopathology, which enhances a pathologist-clinician communication [3]. The high diagnostic accuracy of FNAC in salivary gland tumors was also confirmed by Farhan *et al.* and it is important in minimizing unnecessary surgical interventions [4]. In addition, Chaithanya B and Umashankar T reported a broad spectrum of

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cytopathological lesions of the salivary glands, and this indicates the flexibility of FNAC in the diagnosis of various pathologies. FNAC has its limitations, although it has its benefits [5]. Similarly, Kasinathan *et al.* demonstrated a high level of diagnostic performance of FNAC in salivary gland lesions when correlated with histopathological examination [6]. These findings suggest that the diagnostic performance of FNAC may vary according to lesion type, sampling adequacy, and anatomical site. Conversely, a study conducted by Seema *et al.* demonstrated that FNAC and histopathology were concordant in oral lesions and thus it should still be used as a diagnostic tool [7]. Innovations like ultrasonography-guided FNAC have further enhanced diagnostic consistency, as demonstrated by Kumar *et al.* especially those that are deep-seated or non-palpable [8]. The success of FNAC depends on many factors, among which are lesion type, sampling method, and operator skills. Mayer *et al.* highlighted the role of lesion-specific and sampling-related factors on the sufficiency and precision of FNAC [9]. Also, validation studies of the Milan reporting system by Reerds *et al.* [10] and comparative analyses by Palacios-Garcia *et al.* have shown it to be effectively used in risk stratification and enhancing diagnostic reproducibility [11]. The diagnostic accuracy of FNAC in swellings of parotid glands was also high, which was also supported by BM *et al.* [12], and increases its clinical significance.

Despite its extensive use, the inconsistency in diagnostic accuracy of FNAC because of sampling, heterogeneity of lesions, and dependence on operators requires further consideration, especially in oral and maxillofacial masses. Furthermore, the lack of local evidence and application of standardized reporting systems is inconsistent, and there is a need to investigate the effectiveness of this method regionally. Thus, the study is warranted to compare the diagnostic value of FNAC in oral and maxillofacial masses and to establish its accuracy compared to the histopathology in the local population. This study aimed to establish the diagnostic accuracy of a fine needle aspiration cytology (FNAC) in oral and maxillofacial masses through a comparison of the results with the reference standard of histopathology.

METHODS

This descriptive cross-sectional study was carried out in the Department of Oral and Maxillofacial Surgery, Jinnah Post-Graduate Medical Centre (JPMC), Karachi, Pakistan, during a period of four months from 5, December 2025 – 5, March 2026 after securing the consent of the Institutional Review Board (IRB), JPMC with approval no: (NO.F.2-81/2025-GENL/755/JPMC) given on 4, December 2025. During the study period, patients arriving with clinically apparent oral and maxillofacial swellings were evaluated regarding their eligibility, and before getting enrolled, they signed informed consent in writing. A non-probability consecutive sampling method was adopted to incorporate all eligible patients until the necessary number of patients was obtained. Consecutive sampling was selected because all eligible patients presenting to the study department during the predefined study period were approached for inclusion, thereby minimizing selective recruitment within the study setting. The single proportion method of estimating diagnostic accuracy was used to determine the sample size. The sample size was calculated using the standard single population proportion formula: $n = Z^2_{1-\alpha/2} \times p\ (1-p) / d^2$, where n = required sample size, Z = standard normal variate corresponding to the 95% confidence level (1.96), p = anticipated diagnostic accuracy (0.90), and d = margin of error (0.05). The calculated sample size was further verified using Open-Epi software. The diagnostic accuracy of 90% fine needle aspiration cytology (FNAC) was estimated, which is based on the previously published literature [4]. The confidence level was 95%, which is equivalent to a Z value of 1.96, and the margin of error was 5%. In order to take into consideration poor, inadequate, or indeterminate aspirates, an extra 10% was considered, and therefore, the final sample population was 139 patients. The method of determining the sample size was based on the conventional principles of biostatistics as explained by Wayne W. Daniel, and recommendations of the World Health Organization. [13]. The study included patients between the ages of 18 years and above bearing palpable oral or maxillofacial masses suspected of being either inflammatory, benign, or malignant in nature, with a willingness and stability to have FNAC. Patients who have bleeding disorders or are on anticoagulant therapy, lesions that cannot be accessed by FNAC due to anatomical features, lesions that recur with prior histopathological results, and poor or non-diagnostic FNAC samples after two attempts were excluded. FNAC was done in an aseptic environment with the use of a 22–25-gauge needle fitted with a 10 mL disposable syringe. The needle was inserted into the palpable lesion after proper site preparation, and negative pressure was applied. A series of one to two passes at varying angles was done in order to achieve sufficient cellular material. The aspirated sample was immediately placed on the glass slides in a clean state; half of the smears were air-dried and stained by Giemsa stain, and the other samples were fixed in alcohol and stained by the Papanicolaou (PAP) method. The examination and reports on all cytological smears were done by an experienced cytopathologist. The current study prepared a total of approximately 278 cytology slides (approximately 2 slides per case). In the case of histopathology, the reference standard comprised 139 surgical biopsy/excision

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specimens that were processed and analyzed. Following FNAC, patients all had surgical excision or biopsy. The fixed tissue samples were processed and embedded in paraffin and sectioned, and stained with Hematoxylin and Eosin (H&E). FNAC results were blinded to the histopathologist to minimize observer bias. The light microscope (Olympus CX43) was used to examine all the cytology and histopathology slides, and a microscope-mounted camera (Olympus DP23) was used to capture digital images under up to 40x magnification. Age, gender, residence, duration and location of swelling, clinical features, FNAC results, and histopathological diagnosis were entered on a pre-tested proforma. All subjects were given their own study identification numbers to protect confidentiality. Data were kept in a password-protected database, which was only available to authorized personnel of the study, and data were checked on a regular basis to ensure accuracy and completeness of the data. The FNAC diagnoses in the present study were interpreted according to the routine cytological assessment used at the study center and were not categorized according to the Milan System for Reporting Salivary Gland Cytopathology.

SPSS version 25.0 was used to carry out statistical analysis. Quantitative variables like age were used to express mean and standard deviation, whereas qualitative variables like gender, site of lesion, and type of lesion used frequencies and percentages. The results of FNAC were compared to the histopathological results on the basis of a 2x2 contingency table to find sensitivity, specificity, positive predictive value, negative predictive value, and the ultimate diagnosis accuracy. There was a subgroup analysis of inflammatory, benign, and malignant lesions.

RESULTS

The research involved the analysis of 139 patients who presented with oral and maxillofacial swellings. The clinical and demographic profile of the participants is summarized. The target population mainly consisted of middle-aged adults, but had a slight male bias. The majority of the patients were residents of urban settings, and shorter period swellings were more common (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants (n=139)

Variables	Category	n (%)
Age (Years)	Mean ± SD	41.6 ± 13.2
Gender	Male	82 (59.0%)
	Female	57 (41.0%)
Residence	Urban	96 (69.1%)
	Rural	43 (30.9%)
Duration of Swelling	≤ 6 Months	88 (63.3%)
	> 6 Months	51 (36.7%)
Site of Lesion	Salivary Glands	61 (43.9%)
	Jaw Bones	46 (33.1%)
	Soft Tissues	32 (23.0%)

FNAC diagnostic performance was compared to the histopathology as the reference standard by cytological versus histopathology results, as presented (Table 2).

Table 2: Comparison of FNAC Results with Histopathological Diagnosis (Reference Standard)

FNAC Result	Histopathology Positive, n	Histopathology Negative, n	Total, n
Positive	61	5	66
Negative	7	66	73
Total	68	71	139

Diagnostic performance for individual lesion categories was calculated using a one-versus-rest approach; therefore, category-specific diagnostic accuracy is not directly equivalent to the overall binary diagnostic accuracy reported in table 2

The current study describes the diagnostic effectiveness of FNAC in inflammatory, benign, and malignant lesions. FNAC demonstrated a high sensitivity, specificity, positive and negative predictive value, and diagnostic accuracy as a whole in all types of lesions. Inflammatory lesions presented the greatest diagnostic accuracy, with malignant lesions coming next, and benign lesions also exhibited strong diagnostic indices. The sensitivity of FNAC was 89.7% (95% CI: 80.2–94.9%), while specificity was 93.0% (95% CI: 84.6–97.0%). Such results demonstrate the ability of FNAC as a first-line diagnostic modality in a broad range of oral and maxillofacial lesions (Table 3).

Table 3: Class-specific Diagnostic Performance of FNAC According to Lesion Category

Lesion Category	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Inflammatory	94.1%	97.5%	94.1%	97.5%	96.8%
Benign	90.5%	92.7%	88.4%	94.2%	91.9%
Malignant	92.3%	96.6%	92.3%	96.6%	95.2%
Overall	89.7%	93.0%	92.4%	90.4%	91.4%

The findings show Smear is moderately cellular, showing a biphasic population of epithelial and myoepithelial cells. The epithelial cells are arranged in cohesive clusters. These cells are uniform with round to oval nuclei fine chromatin, and inconspicuous nucleoli (A). Myoepithelial cells are seen in abundance, exhibiting a spindle-shaped appearance. The background is chondromyxoid. No nuclear atypia, pleomorphism, mitotic activity, or necrosis is identified (B). No features suggestive of malignancy are seen (Figure 1).

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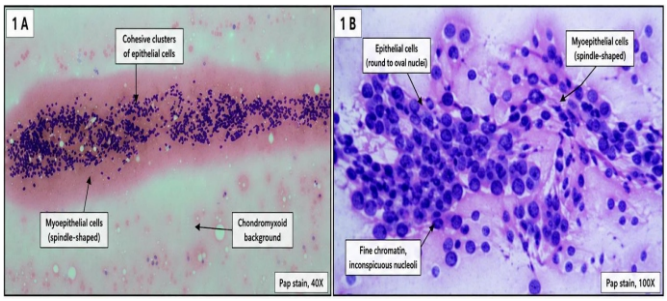


Figure 1: Biphasic Population of Epithelial (A) And Myoepithelial Cells(B)

The results show groups, acini, and honeycombing or duct-like structures) of ductal epithelial and myoepithelial cells with a fibrillary stroma(Figure 2).

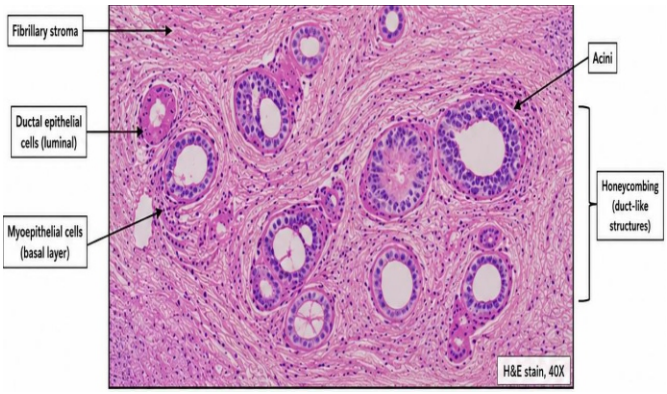


Figure 2: Ductal Epithelial and Myoepithelial Cells with a Fibrillary Stroma

DISCUSSION

The current research assessed the diagnostic accuracy of the fine needle aspiration cytology (FNAC) in the diagnosis of oral and maxillofacial swellings by the gold standard of histopathology. The general accuracy of diagnostic results in this study was good, sensitivity and specificity were high, which justifies the use of FNAC as a sensible first-line diagnostic method. These results are in line with the findings of Palacios-Garcia *et al.* who showed similar diagnostic capabilities of FNAC with the Milan system when compared to definitive histology in tumors of the salivary glands [11]. On the same note, BM *et al.* demonstrated that FNAC has high diagnostic accuracy when used in diagnosing parotid gland swellings, thereby supporting its use as an effective preoperative investigation [12]. The high correlation between cytological and histopathological results in the current study is also proven by the findings of AlGhamdi *et al.* where it is noted that the FNAC and permanent histopathology have high levels of agreement in salivary gland masses [14]. FNAC Diagnostic reliability has been greatly enhanced by the integration of standardized reporting systems like the Milan system. Improved accuracy and reproducibility of salivary gland cytopathology with the Milan system was reported by Rammeh *et al.* and is consistent with the diagnostic consistency in the present study [15]. Mourouzis *et al.* also pointed to the importance of FNAC in a long-term tertiary care experience, and its ability to decrease the number of unnecessary surgical operations [16]. Lesions experienced by salivary gland cytopathology are very diverse, and FNAC is essential in the classification of lesions. Datta *et al.* showed that the Milan system is efficient in classifying salivary gland lesions, a factor that enhances diagnostic clarity [17]. Arya *et al.* also observed the fact that structured reporting leads to increased diagnostic accuracy and clinical decision-making [18], which is evident in the high performance of FNAC in the current study. FNAC reliability is also supported by international evidence. Rossi *et al.* emphasized that the Milan system enhances risk stratification and diagnostic accuracy in a variety of institutions, which leads to improved clinical outcomes [19]. The results of the current study were also confirmed by Singh *et al.* who showed that FNAC and histopathology are highly correlated in salivary gland lesions [20]. Additional proof by Gupta *et al.* indicated that FNAC is highly diagnostic in a tertiary care environment, especially as a component of a systematic diagnostic procedure [21]. On the whole, the results of this paper demonstrate that FNAC is a fast, minimally invasive diagnostic tool used when working with oral and maxillofacial swellings, and it is highly correlated with histopathological diagnosis. Making it a useful first-line investigative tool in clinical practice, its accuracy is further boosted by standardized reporting systems like the Milan system.

This study has some limitations. The use of non-probability consecutive sampling may restrict the external validity of the findings, while the single-center design may introduce selection and referral bias, particularly due to the nature of cases managed at a tertiary-care hospital. Operator dependency in FNAC sampling and cytological interpretation may also influence diagnostic accuracy and reproducibility. Furthermore, persistently non-diagnostic samples were excluded, which may have contributed to an overestimation of diagnostic performance. In addition, the sample size calculation relied on diagnostic accuracy estimates derived from another institution, which may limit the generalizability of the assumed accuracy to our study setting. Although standardized reporting systems such as the Milan System may improve diagnostic consistency, it was not formally applied in the present study. In addition, cost-effectiveness and the potential reduction in unnecessary surgical procedures were not evaluated. Future multicenter studies involving larger samples, lesion-specific analysis, standardized reporting systems, and multiple observers are recommended to further

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validate the diagnostic accuracy and clinical utility of FNAC.

CONCLUSIONS

In conclusion, FNAC demonstrated good diagnostic performance for oral and maxillofacial swellings when compared with histopathology, with high sensitivity, specificity, and overall diagnostic accuracy in the present study. These findings support the role of FNAC as a useful minimally invasive first-line diagnostic investigation and as an aid to preoperative clinical decision-making. However, the findings should be interpreted in the context of the single-center design, non-probability sampling, exclusion of persistently non-diagnostic samples, and reliance on a single cytopathologist.

Authors' Contribution

Conceptualization: MM
Methodology: MM, JA, HR, WB, SS, RS
Formal analysis: MM, WB, SS
Writing and Drafting: MM, JA, HR
Review and Editing: MM, JA, HR, WB, SS, RS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflict of Interest

All the authors declare no conflict of interest.

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