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Original Research Article

Diagnostic Utility of Fine Needle Aspiration Cytology in Salivary Gland Lesions with Histopathological Correlation: A Cross-Sectional Study from a Tertiary Care Centre in Northeast India

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Abstract

Background: Salivary gland lesions are a heterogeneous group of disorders ranging from inflammatory and non-neoplastic lesions to benign and malignant neoplasms. Accurate pre-operative diagnosis is essential for correct management and surgical planning. Fine Needle Aspiration Cytology (FNAC) is a simple, minimally invasive and cost-effective diagnostic modality which has gained wide acceptance in evaluation of salivary gland lesions.

Objectives: To evaluate the diagnostic utility of FNAC in salivary gland lesions and to correlate the cytological findings with histopathological diagnosis whenever possible.

Materials and Methods: This hospital based cross sectional study was conducted in Department of Pathology, Assam Medical College and Hospital, Dibrugarh during a period of one year from June 2016 to May 2017. FNAC was performed in 68 patients presenting with salivary gland swellings. Histopathological correlation was available in 34 cases. We used histopathology as the gold standard to calculate diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy and Cohen's kappa coefficient.

Results: The patients' ages ranged from 10 to 73 years, with a mean of 38 years. Most of the patients were in 30–39 years age group (25%). There were 52.95% females in the cases and the male to female ratio was 1:1.25. Parotid gland was the most common site (73.53%) followed by submandibular gland (17.65%) and minor salivary glands (8.82%). Non-neoplastic lesions were 47.06% of cases and the most common lesion was sialadenitis. The most common benign neoplasm was pleomorphic adenoma and the most common malignant tumour was mucoepidermoid carcinoma. Histopathological correlation showed sensitivity of 77.77%, specificity of 100%, PPV of 100%, NPV of 92.59% and diagnostic accuracy of 94.11%. There was a good agreement between cytological and histopathological diagnosis (Cohen's kappa coefficient = 0.83).

Conclusion: FNAC is a very specific, reliable and inexpensive tool for diagnosis of salivary gland lesions. The present study has shown high diagnostic accuracy and excellent cytohistological concordance which supports its use as a first line investigation in patients presenting with salivary gland swellings.

Keywords: Fine Needle Aspiration Cytology; Salivary Gland Lesions; Histopathology; Pleomorphic Adenoma; Mucoepidermoid Carcinoma; Diagnostic Accuracy.

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Introduction

Lesions of the salivary glands encompass a wide spectrum of pathological entities including developmental anomalies, inflammatory diseases, cystic lesions, benign neoplasms and malignant tumours. Neoplasms of salivary glands are clinically important although they are relatively uncommon, accounting for 2–6.5% of all head and neck neoplasms, and have a varied histological appearance and biological behaviour. Salivary gland pathology presents a diagnostic challenge to the clinician, radiologist and pathologist because of its complexity. Thus, accurate preoperative diagnosis is essential for the selection of the most appropriate treatment strategy and for minimizing patient morbidity. Salivary glands are divided into major & minor salivary glands. Major salivary glands include the parotid, submandibular and sublingual glands and there are hundreds of minor

salivary glands distributed throughout the oral cavity and upper aerodigestive tract. The vast majority of all salivary gland tumours (64–80%) develop in the parotid gland, 7–11% in the submandibular gland, less than 1% in the sublingual gland and 9–23% in the minor salivary glands. The rate of malignancy increases with decreasing gland size and therefore accurate diagnosis is especially important in lesions occurring in smaller glands.

Clinical presentation of salivary gland lesions are painless/painful swellings, rapidly growing masses, recurrent inflammatory episodes or may be incidental findings during radiological evaluation. By clinical examination alone, benign lesions often cannot be differentiated from malignant lesions. Therefore, usually a combination of clinical assessment, imaging studies, cytological evaluation, and histopathological examination is needed to make a definitive diagnosis.

Of the diagnostic modalities available, Fine Needle Aspiration Cytology (FNAC) has become one of the most valuable initial investigations in the assessment of salivary gland swellings. FNAC has remained an integral part of routine diagnostic practice since its introduction in the latter half of the twentieth century. The procedure consists of aspiration of cellular material with a fine gauge needle and subsequent cytomorphological examination of stained smears. Because of the minimal invasiveness, cost-effectiveness, speed and patient tolerance of the technique, it is especially useful in outpatient settings and resource-limited healthcare settings.

FNAC has several advantages in the evaluation of salivary gland lesions. First, it is useful in differentiating non-neoplastic lesions from neoplastic conditions. Secondly, it gives useful information on the nature of the lesion and can help to distinguish benign from malignant tumours. Third, the cytological diagnosis can help in surgical planning by defining the extent of resection and the need for neck dissection. Finally, FNAC may help to avoid unnecessary surgery in inflammatory or reactive lesions that can be managed conservatively.

Although FNAC has its advantages, it has limitations. The mixed morphology of salivary gland neoplasms may overlap cytologic characteristics of different lesions. Sampling errors, cystic degeneration, inadequate aspirates and tumour heterogeneity may all contribute to false negative or, occasionally, false positive diagnoses. Diagnostic challenges can be significant in some neoplasms, such as low-grade mucoepidermoid carcinoma, acinic cell carcinoma and polymorphous adenocarcinoma, due to their subtle cytological atypia and overlapping features with benign lesions. Therefore, histopathological examination is the gold standard for definitive diagnosis. FNAC has been evaluated for its diagnostic utility in salivary gland pathology in many studies. Published studies have reported sensitivities ranging from 66% to 100%, specificities from 94% to 100%, and in many series diagnostic accuracy greater than 90%. The diagnostic performance of FNAC depends upon many factors including experience of the cytopathologist, adequacy of sampling, quality of smear preparation and correlation with clinical and radiological findings. Recently, the importance of cytohistopathological correlation has been repeatedly stressed to improve the reliability of diagnosis and to locate areas of probable diagnostic difficulty.

In developing countries, where health care resources may be limited and access to advanced imaging modalities may not always be readily available, FNAC assumes even greater importance. It is inexpensive, has a rapid turnaround time and a high diagnostic accuracy and is therefore particularly suitable for routine evaluation of salivary gland lesions. Early and accurate diagnosis can also significantly reduce patient anxiety, enable prompt treatment and improve overall clinical outcomes.

FNAC has been studied in several studies of salivary gland lesions but data from Northeast India is relatively scarce. Regional studies are important because disease patterns, access to health care, demographic characteristics and environmental influences may vary by geographical locations. Therefore, determination of the diagnostic utility of FNAC in the local population can be of value to the clinicians and pathologists working in similar settings.

The present study was done in the Department of Pathology, Assam Medical College and Hospital, Dibrugarh with the objective to evaluate the diagnostic utility of Fine Needle Aspiration Cytology in salivary gland lesions and its correlation with histopathological findings whenever available. The study also aimed at determining the pattern of distribution of salivary gland lesions encountered at this tertiary care centre and to analyze the diagnostic accuracy of FNAC using histopathology as the reference standard.

Materials and Methods

Study Design and Setting: The present study was a hospital-based cross-sectional observational study conducted in the Department of Pathology, Assam Medical College and Hospital (AMCH), Dibrugarh, Assam, India. The study was carried out over a period of one year from June 2016 to May 2017.

Assam Medical College is a tertiary care referral centre catering to a large population from Assam and neighbouring northeastern states, providing a wide spectrum of pathological specimens for evaluation.

Study Population: The study included all patients presenting with clinically evident salivary gland swellings who were referred to the Cytology Section of the Department of Pathology for Fine Needle Aspiration Cytology (FNAC) during the study period. Patients belonged to different age groups and both sexes.

Inclusion Criteria

The following patients were included in the study:

1. Patients presenting with swellings involving major salivary glands (parotid, submandibular, and sublingual glands).
2. Patients presenting with swellings involving minor salivary glands.
3. Patients who provided informed written consent for participation in the study and FNAC procedure.
4. Cases in which adequate cytological material could be obtained for evaluation.

Exclusion Criteria

The following patients were excluded from the study:

1. Patients with known haemorrhagic disorders or bleeding diathesis.
2. Patients with active skin infection at the site of aspiration.
3. Non-cooperative patients unwilling to undergo the procedure.
4. Patients who declined to provide informed consent.

Sample Size: The sample size consisted of all salivary gland lesions reported during the one-year study period. A total of 68 cases fulfilled the inclusion criteria and were included in the study. Histopathological correlation was available in 34 cases.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Human Ethics Committee of Assam Medical College and Hospital, Dibrugarh. Written informed consent was obtained from all adult participants prior to aspiration. In the case of minors, consent was obtained from parents or legal guardians. Confidentiality of patient information was maintained throughout the study.

Study Protocol: Each patient underwent detailed clinical evaluation prior to aspiration. Clinical information was recorded using a predesigned proforma that included:

- Age and sex of the patient
- Duration of swelling
- Site and size of lesion
- Associated symptoms such as pain or facial nerve involvement
- Clinical diagnosis
- Relevant radiological investigations, wherever available
- Previous treatment history

The collected clinical information was correlated with cytological and histopathological findings to arrive at the final diagnosis.

Fine Needle Aspiration Cytology Procedure: Fine Needle Aspiration Cytology was performed before any surgical intervention. The procedure was carried out in the Cytology Section of the Department of Pathology or at the bedside in hospitalized patients when necessary.

Materials Used

The following materials were utilized:

- Disposable aspiration needles (22–25 gauge)
- 10 mL plastic syringes
- Syringe holder
- Clean glass slides
- Methanol and ethanol
- Antiseptic solution
- May-Grünwald Giemsa (MGG) stain
- Hematoxylin and Eosin (H&E) stain

Aspiration Technique: The patient was positioned comfortably, usually in the supine position with slight neck extension when required. After identifying the lesion clinically, the skin over the aspiration site was cleaned thoroughly using antiseptic solution.

The swelling was stabilized with one hand while the needle attached to a syringe was inserted into the lesion. Negative pressure was generated by retracting the syringe plunger.

The needle was moved in multiple directions within the lesion while maintaining suction to obtain representative cellular material. Once adequate material had been aspirated, suction was released before withdrawing the needle to prevent contamination of the needle tract.

The needle was detached from the syringe, the syringe was filled with air, and the aspirated material was expelled onto clean glass slides. Usually, three to four smears were prepared from each aspiration. Aspirations were performed from more than one site whenever required to improve diagnostic yield.

No significant complications were encountered during the procedure.

Preparation and Fixation of Smears: Both air-dried and alcohol-fixed smears were prepared.

Air-Dried Smears: Air-dried smears were stained using the May-Grünwald Giemsa (MGG) technique for evaluation of cytoplasmic morphology, stromal elements, inflammatory cells, and background characteristics.

Alcohol-Fixed Smears: Smears intended for Hematoxylin and Eosin staining were immediately fixed in 95% ethanol for adequate preservation of nuclear morphology.

Cytological Staining Methods

May-Grünwald Giemsa Staining: The MGG staining technique was employed for routine examination of air-dried cytological preparations.

Staining Procedure

1. Air-dried smears were fixed in methanol for 5 minutes.
2. Smears were stained with May-Grünwald working solution for 3–5 minutes.
3. Giemsa working solution was applied for 5–10 minutes.
4. Slides were washed in running tap water.
5. Smears were air dried and mounted for microscopic examination.

Hematoxylin and Eosin Staining: Alcohol-fixed smears were stained using Hematoxylin and Eosin stain for detailed nuclear and cytoplasmic assessment.

Staining Procedure

1. Smears were fixed in ethanol for 15–20 minutes.
2. Slides were hydrated through descending grades of alcohol.
3. Hematoxylin staining was performed.
4. Differentiation and bluing were carried out.
5. Eosin staining was applied.
6. Slides were dehydrated, cleared, and mounted using DPX.

Cytological Evaluation: All stained smears were examined under light microscopy. Cytological diagnosis was rendered based on the following parameters:

- Cellularity of aspirate
- Cellular arrangement
- Nuclear morphology
- Cytoplasmic characteristics
- Presence of stromal material
- Inflammatory infiltrate
- Necrosis and background features

Based on cytomorphological findings, lesions were categorized into:

1. Non-neoplastic lesions
2. Benign neoplastic lesions
3. Malignant neoplastic lesions

Specific cytological diagnoses were made whenever possible.

Histopathological Examination: Histopathological examination was performed in patients who subsequently underwent surgical excision or biopsy.

Tissue Processing: Surgically excised specimens were fixed in 10% neutral buffered formalin for adequate fixation. Following gross examination, representative tissue sections were obtained and processed according to standard histopathological protocols.

The processing steps included:

1. Fixation
2. Dehydration in ascending grades of alcohol
3. Clearing in xylene
4. Paraffin embedding
5. Microtome sectioning at 3–5 μm thickness
6. Mounting on glass slides
7. Hematoxylin and Eosin staining

The stained sections were examined microscopically and histopathological diagnosis was established.

Cytohistopathological Correlation: Histopathological diagnosis was considered the gold standard. Cytological findings obtained by FNAC were compared with final histopathological diagnoses wherever tissue specimens were available.

Correlation was performed to assess:

- Concordance between FNAC and histopathology
- Diagnostic accuracy of FNAC
- Sources of diagnostic discrepancy
- Reliability of FNAC in differentiating benign and malignant lesions

Statistical Analysis: Data obtained during the study were entered into tabulated format and analyzed using standard statistical methods.

The diagnostic efficacy of FNAC was evaluated using the following parameters:

Sensitivity: Sensitivity was defined as the ability of FNAC to correctly identify malignant lesions.

$$\text{Sensitivity (\%)} = TP / (TP + FN) \times 100$$

Specificity: Specificity was defined as the ability of FNAC to correctly identify non-malignant lesions.

$$\text{Specificity (\%)} = TN / (TN + FP) \times 100$$

Positive Predictive Value (PPV): PPV represented the probability that lesions diagnosed as malignant by FNAC were truly malignant.

PPV (%) = TP / (TP + FP) × 100

Negative Predictive Value (NPV): NPV represented the probability that lesions diagnosed as benign by FNAC were truly benign.

NPV (%) = TN / (TN + FN) × 100

Diagnostic Accuracy: Diagnostic Accuracy (%) = (TP + TN) / (TP + TN + FP + FN) × 100

Cohen's Kappa Coefficient: The degree of agreement between cytological and histopathological diagnoses was assessed using Cohen's kappa coefficient (κ).

Interpretation of Kappa Values:

- ≤25% : Mild agreement
- 26–50% : Moderate agreement
- 51–75% : Strong agreement
- 75% : Excellent agreement

A p-value of less than 0.05 was considered statistically significant wherever applicable.

This methodology enabled systematic evaluation of the diagnostic utility of FNAC in salivary gland lesions and assessment of its concordance with histopathological diagnosis.

Results

Overview of Study Population: The present study entitled "Diagnostic Utility of fine needle aspiration cytology in salivary gland lesions with histopathological correlation: A cross-sectional study from a tertiary care centre in Northeast India" was conducted in the Department of Pathology, Assam Medical College and Hospital, Dibrugarh, over a period of one year from June 2016 to May 2017.

A total of 68 patients presenting with salivary gland swellings underwent Fine Needle Aspiration Cytology (FNAC). Histopathological correlation was available in 34 cases, and these cases were utilized for assessing the diagnostic efficacy of FNAC.

Age Distribution

Table 1: Age Distribution of Patients with Salivary Gland Lesions (n = 68)

Age Group (Years)	Number (n)	Percentage (%)
<10	0	0.00
10–19	7	10.29
20–29	13	19.12
30–39	17	25.00
40–49	12	17.65
50–59	12	17.65
60–69	5	7.35
≥70	2	2.94
Total	**68**	**100.00**

The age of patients ranged from 10 to 73 years, with a mean age of 38 years.

The maximum number of cases occurred in the 30–39 years age group (25%), followed by the 20–29 years age group (19.12%). The findings indicate that salivary gland lesions predominantly affect young and middle-aged adults. The declining frequency in older age groups suggests that a substantial proportion of lesions encountered in the present study were benign or inflammatory conditions that typically occur earlier in life.

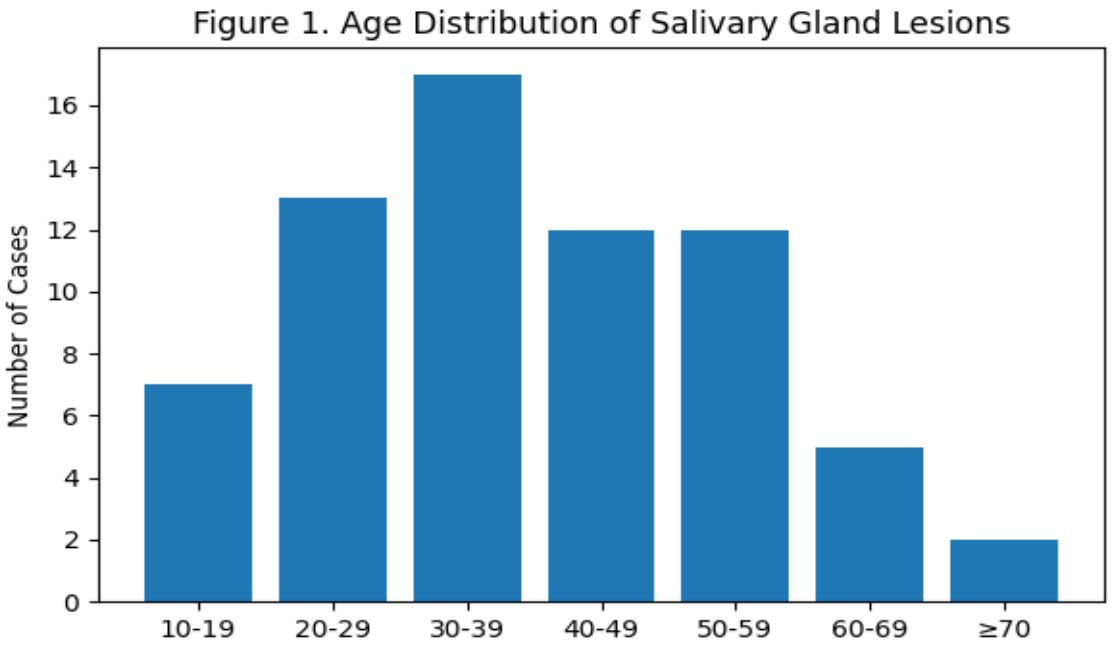

Figure 1: Age distribution of patients with salivary gland lesions showing maximum prevalence in the 30–39 years age group.

Age-wise Distribution Pattern of Salivary Gland Lesions

Table 2: Age-wise Distribution of Various Salivary Gland Lesions

Lesion Type	<10	10–19	20–29	30–39	40–49	50–59	60–69	≥70
Non-neoplastic	0	4	5	10	4	5	3	1
Pleomorphic adenoma	0	3	7	5	5	1	1	0
Warthin tumour	0	0	0	0	1	1	0	1
Basal cell adenoma	0	0	0	0	2	1	0	0
Mucoepidermoid carcinoma	0	0	1	2	0	3	0	0
Adenoid cystic carcinoma	0	0	0	0	0	0	1	0
Acinic cell carcinoma	0	0	0	0	0	1	0	0

Among benign lesions, the highest frequency was observed in the 30–39 years age group. Pleomorphic adenoma showed a predilection for younger and middle-aged adults, particularly between the second and fifth decades of life. Malignant lesions demonstrated a different age pattern. Most malignant tumours occurred in patients aged 50–59 years, indicating an increasing risk of malignancy with advancing age. Mucoepidermoid carcinoma, the commonest malignant tumour in this series, was predominantly encountered after the fourth decade.

These findings are consistent with the known epidemiology of salivary gland neoplasms, where malignant lesions generally occur later in life compared with benign tumours.

Sex Distribution

Table 3: Sex Distribution of Salivary Gland Lesions

Sex	Number (n)	Percentage (%)
Male	32	47.05
Female	36	52.95
Total	**68**	**100.00**

Of the 68 patients studied, 36 (52.95%) were females and 32 (47.05%) were males, producing a male-to-female ratio of 1:1.25. The slight female predominance observed in the present study suggests a marginally higher occurrence of salivary gland lesions among women. Female predominance was observed across both benign and malignant lesion categories.

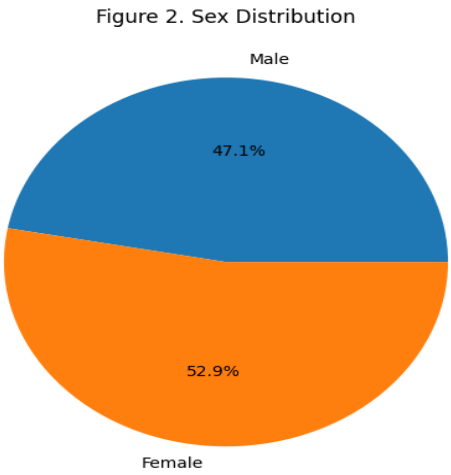

Figure 2: Pie chart depicting sex distribution of salivary gland lesions demonstrating slight female predominance.

Site Distribution of Salivary Gland Lesions

Table 4: Site Distribution of Salivary Gland Lesions

Site	Number (%)
Parotid gland	73.53
Submandibular gland	17.65
Minor salivary glands	8.82
Sublingual gland	0
Total	100

The parotid gland was the most frequently involved site, accounting for nearly three-fourths of all lesions.

The submandibular gland constituted the second most common site, whereas minor salivary glands contributed a relatively small proportion of cases.

No lesion was encountered in the sublingual gland during the study period.

The predominance of parotid gland involvement reflects the larger volume of glandular tissue present in this gland and its susceptibility to both inflammatory and neoplastic processes.

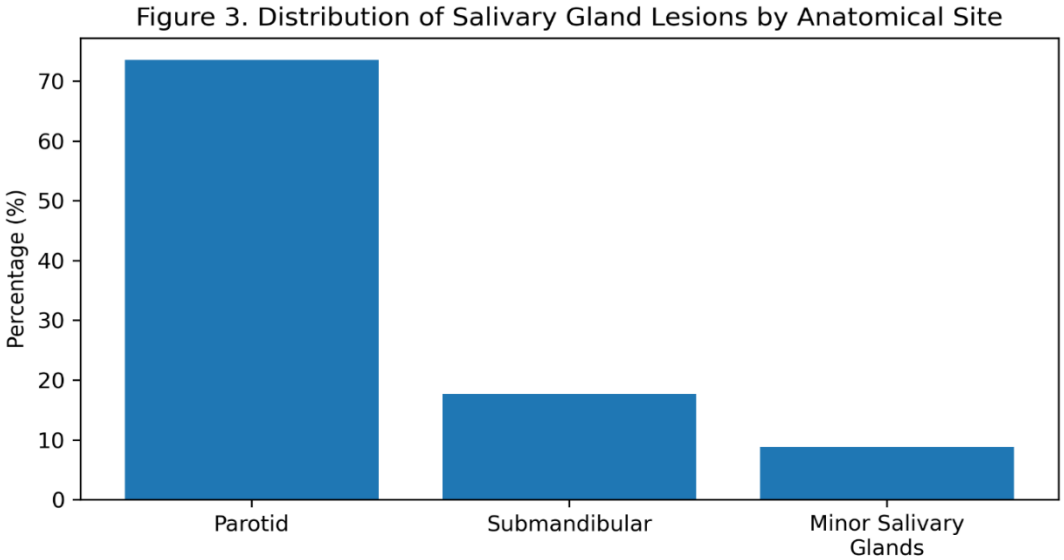

Figure 3: Distribution of salivary gland lesions according to anatomical site, highlighting predominant involvement of the parotid gland.

Distribution According to Histopathological Nature: The majority of lesions encountered were non-neoplastic and benign in nature. Sialadenitis represented the most common non-neoplastic lesion. Among benign tumours, pleomorphic adenoma was the predominant neoplasm, whereas mucoepidermoid carcinoma constituted the most frequent malignant tumour.

Clinical Interpretation: This distribution highlights the fact that most salivary gland swellings encountered in routine clinical practice are benign or inflammatory lesions.

Nevertheless, the presence of malignant tumours in older age groups emphasizes the importance of accurate preoperative diagnosis to guide treatment planning.

Cytohistopathological Correlation: Histopathological examination was available in 34 cases and was used as the gold standard for evaluating diagnostic accuracy.

Table 5. Cytohistopathological Correlation

Cytological Diagnosis	Histopathological Correlation
Sialadenitis (6)	All confirmed
Pleomorphic adenoma (14)	13 confirmed, 1 diagnosed as mucoepidermoid carcinoma
Warthin tumour (3)	All confirmed
Basal cell adenoma (3)	2 confirmed, 1 diagnosed as pleomorphic adenoma
Mucoepidermoid carcinoma (6)	5 confirmed, 1 diagnosed as polymorphous low-grade adenocarcinoma
Adenoid cystic carcinoma (1)	Confirmed

Excellent agreement was observed between FNAC and histopathological diagnosis. Most discrepancies occurred in tumours exhibiting overlapping cytomorphological features, particularly pleomorphic adenoma and low-grade malignant tumours.

One case diagnosed cytologically as pleomorphic adenoma was subsequently identified as mucoepidermoid carcinoma on histopathological examination. Similarly, one cytological diagnosis of mucoepidermoid carcinoma was revised to polymorphous low-grade adenocarcinoma after histological examination. These findings emphasize that although FNAC is highly reliable, histopathological confirmation remains essential in selected cases because of tumour heterogenciity and sampling limitations.

Diagnostic Utility of FNAC

Table 6: Diagnostic Efficacy of FNAC

Histopathology	Malignant	Non-Malignant	Total
FNAC Positive	7 (True Positive)	0 (False Positive)	7
FNAC Negative	2 (False Negative)	25 (True Negative)	27
Total	9	25	34

Table 7: Diagnostic Performance Parameters

Parameter	Value (%)
Sensitivity	77.77
Specificity	100.00
Positive Predictive Value	100.00
Negative Predictive Value	92.59
Diagnostic Accuracy	94.11
Kappa Coefficient	0.83

The diagnostic performance of FNAC in the present study was highly satisfactory. The sensitivity of 77.77% indicates that FNAC correctly identified approximately three-fourths of malignant lesions. The specificity of 100% demonstrates the absence of false-positive diagnoses, indicating that lesions categorized as malignant cytologically were truly malignant on histopathological examination.

The positive predictive value of 100% further supports the reliability of a positive cytological diagnosis of malignancy. The negative predictive value of 92.59% indicates a high probability that lesions diagnosed as benign were indeed benign.

The overall diagnostic accuracy of 94.11% highlights the effectiveness of FNAC as a screening and diagnostic tool in salivary gland pathology. Furthermore, the kappa coefficient of 0.83 indicates excellent agreement between cytological and histopathological diagnoses, confirming the reproducibility and reliability of FNAC.

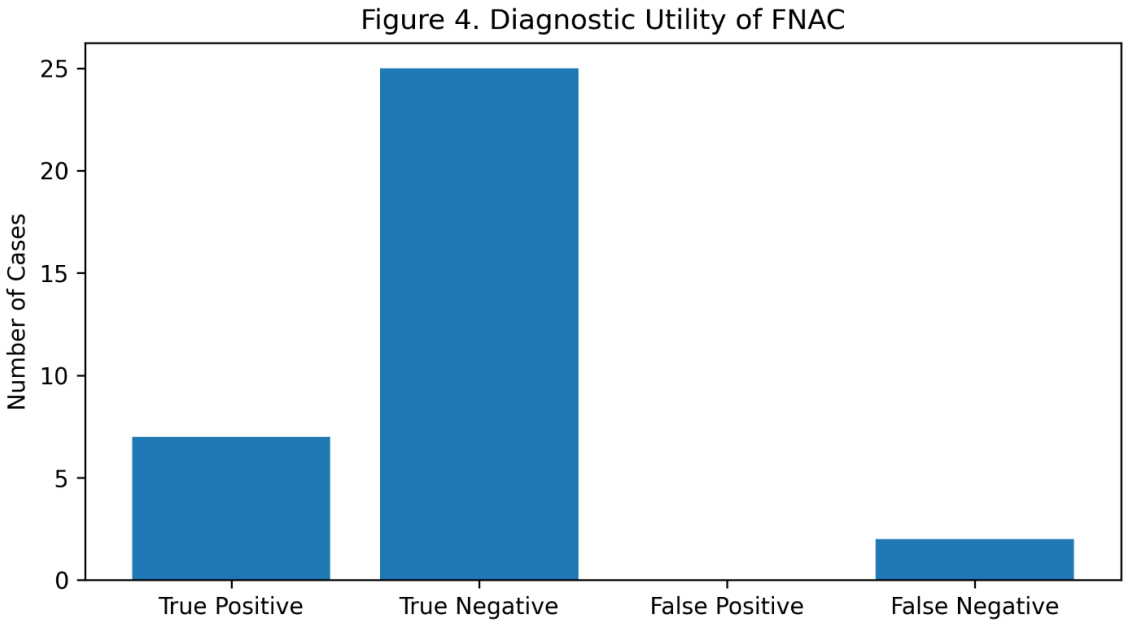

Figure 4: Diagnostic utility of FNAC showing distribution of true positive, true negative, false positive, and false negative cases used in calculation of diagnostic parameters.

Summary of Results

The present study demonstrated that salivary gland lesions were most frequently encountered in adults aged 30–39 years and showed a slight female predominance. The parotid gland was the most commonly affected site. Non-neoplastic lesions constituted the largest diagnostic category, while pleomorphic adenoma and mucoepidermoid carcinoma were the most common benign and malignant tumours, respectively.

Cytohistopathological correlation revealed excellent concordance between FNAC and histopathology. FNAC demonstrated a sensitivity of 77.77%, specificity of 100%, and overall diagnostic accuracy of 94.11%, establishing it as a highly effective diagnostic modality in the evaluation of salivary gland lesions.

Discussion

Lesions of the salivary glands are a broad and heterogeneous group of pathologic entities, ranging from inflammatory/reactive conditions to benign and malignant neoplasms. Preoperative diagnosis of salivary gland lesions is difficult due to wide spectrum of histological patterns and overlap in clinical presentation. Fine Needle Aspiration Cytology (FNAC) has become an important diagnostic procedure in the evaluation of salivary gland swellings because of its simplicity, rapidity, safety, cost-effectiveness and minimally invasive nature. The present study was undertaken to evaluate the diagnostic utility of Fine Needle Aspiration Cytology (FNAC) in the lesions of salivary gland and its correlation with histopathological findings wherever available. In the present study, a total of 68 cases of salivary gland lesions were studied over a period of one year. Histopathological correlation was available in 34 cases. The age of the patients ranged from 10 to 73 years. The highest frequency of cases was noticed in the 30-39 years age group. Similar results have been reported by Rajvedo et al. and Jaafari-Ashkavandi et al. who have observed that salivary gland lesions are more encountered in individuals in the third to fifth decades of life [1,2]. The predominance of lesions in young and middle-aged adults observed in the present study may be due to the high proportion of inflammatory lesions and benign tumours, especially pleomorphic adenoma, which occur in these decades.

There was a slight predominance of females in the present study, with females constituting 52.95% of all cases and a male-to-female ratio of 1:1.25. Ersoz et al., and Devi et al. have also reported female predilection in patients with salivary gland lesions [3,4]. The reason for the difference between the genders is unknown, but the increased incidence of benign salivary gland neoplasms in females may be contributing. Further, malignant lesions in the present series also showed a slight female predominance, similar to what has been reported in several Indian studies.

The parotid gland was the most common site of involvement with 73.53% of all lesions. This finding is in agreement with the well-known epidemiological pattern of salivary gland pathology and closely corresponds with the reports of Boccato et al, Arul et al and Upasana et al, who identified

the parotid gland as the most common site of involvement [5–7]. The preponderance of the parotid gland is probably due to its large size, its extensive glandular tissue, and its greater exposure to various pathological processes. The submandibular gland was the second most frequent site involved and only a minority of lesions originated from minor salivary glands. No injury of the sublingual gland was observed during the study period.

The most common lesions in the present study were within the non-neoplastic lesion category with 47.06% of all cases. The most common diagnosis was sialadenitis. Similar observations have been reported by Akhtar et al and Arul et al where inflammatory lesions form a significant proportion of salivary gland swellings [8,9]. The high prevalence of inflammatory lesions highlights the value of FNAC as a diagnostic modality that can spare unnecessary surgical intervention in patients who can benefit from conservative management.

Pleomorphic adenoma was the most common tumour among benign neoplasms. This finding is consistent with many studies worldwide, including Rajdeo et al., Anand et al., and Jaafari-Ashkavandi et al., who have all reported pleomorphic adenoma as the most common benign salivary gland neoplasm [1,2,10]. Pleomorphic adenoma has a remarkable morphological diversity due to the different proportions of epithelial, myoepithelial and stromal components. In spite of this heterogeneity, FNAC was very good in the diagnosis of pleomorphic adenoma with histopathological confirmation obtained in most of the cases.

Mucoepidermoid carcinoma was the most common malignant tumour in the present study. This is in agreement with the World Health Organization classification and several clinicopathological studies which showed mucoepidermoid carcinoma to be the most common malignant salivary gland tumor [11,12].

The cytologic diagnosis of mucoepidermoid carcinoma may be sometimes challenging due to the variable composition of mucus, squamous, and intermediate cells. In low grade lesions the aspirate may consist of abundant mucin and relatively bland epithelial cells leading to diagnostic confusion with benign cystic lesions or pleomorphic adenoma. One such discrepancy faced in the present study was a lesion diagnosed cytologically as pleomorphic adenoma, which was later found to be mucoepidermoid carcinoma on histopathological examination.

Histopathological correlation showed good correlation with the cytological diagnosis in majority of cases. All the six cases of sialadenitis diagnosed by FNAC were confirmed histologically. Similar in all the three cases of Warthin tumour and in a single case of adenoid cystic carcinoma there was complete concordance between cytological and histopathological findings. These observations underscore the reliability of FNAC in diagnosis of inflammatory and neoplastic salivary gland lesions.

The overall diagnostic accuracy of FNAC in the present study was very satisfactory. The sensitivity for detection of malignant lesions was 77.77% and specificity was 100%. The positive predictive value was 100% and the negative predictive value was 92.59%. Overall diagnostic accuracy was 94.11%. The results are in good agreement with the previously published ones. Verma reported a diagnostic accuracy of 94.05%, sensitivity of 88% and specificity of 96.6% [13]. Kakoty et al. reported sensitivity of 90.91%, specificity of 96.42% and diagnostic accuracy of 94.87% [14]. Similarly Jain et al. reported sensitivity of 87.50%, specificity of 97.44% and diagnostic accuracy of 94.54% [15].

The lower sensitivity in the present study may be explained by sampling limitations and tumour heterogeneity (false-negative cases). Salivary gland tumours often show a high degree of morphological variation in different parts of the same lesion. Thus, aspiration of a nonrepresentative area may result in inadequate diagnostic material. Low-grade mucoepidermoid carcinoma, polymorphous adenocarcinoma, and carcinoma ex pleomorphic adenoma pose special diagnostic problems because of overlapping cytologic features. Low-grade malignant tumours have been found to be common causes of false negative diagnoses in salivary gland cytology [16–18]. Orell and Nettle, Jayaram et al. and Joseph et al. have reported similar findings.

One of the most important findings of the present study was the excellent cytohistopathological agreement revealed by a Cohen's kappa coefficient of 0.83. A kappa value of >0.75 is considered to represent excellent agreement based on the accepted criteria. Similar findings have been reported by Piccioni et al with kappa value of 0.85 and Jain et al with kappa value of 0.865 [15,19]. These observations emphasize the reliability and reproducibility of FNAC when done and interpreted by experienced cytopathologists. The present study confirms FNAC is still an invaluable diagnostic tool in assessment of salivary gland lesions. It is a fast, safe, minimally invasive and cost effective procedure especially in the resource limited healthcare settings. Preoperative diagnosis of salivary gland lesions by FNAC is accurate and helps in proper treatment planning avoiding unnecessary surgical interventions and improving patient outcome. However, histopathological examination remains the gold standard for definitive diagnosis, especially for lesions with

atypical cytological features or clinicopathological discordance.

To conclude, the findings of this study strongly favour the continued use of FNAC as a first-line diagnostic investigation in the patients presenting with salivary gland swellings. The high specificity, excellent diagnostic accuracy and strong cytohistopathological correlation in the present study emphasize on its important role in contemporary salivary gland pathology.

Conclusion

The present study evaluated the diagnostic utility of Fine Needle Aspiration Cytology (FNAC) in the assessment of salivary gland lesions and correlated cytological findings with histopathological diagnosis wherever possible. A total of 68 salivary gland lesions were studied, with histopathological correlation available in 34 cases.

The study demonstrated that salivary gland lesions occurred over a wide age range, with the highest incidence observed in the third and fourth decades of life. A slight female predominance was noted, and the parotid gland emerged as the most commonly affected anatomical site. Non-neoplastic lesions constituted the largest category of lesions, with sialadenitis being the most frequent diagnosis.

Among neoplastic lesions, pleomorphic adenoma was the most common benign tumour, whereas mucoepidermoid carcinoma represented the most common malignant neoplasm.

Histopathological correlation confirmed the high diagnostic reliability of FNAC. The procedure demonstrated a sensitivity of 77.77%, specificity of 100%, positive predictive value of 100%, negative predictive value of 92.59%, and overall diagnostic accuracy of 94.11%. The Cohen's kappa coefficient of 0.83 indicated excellent agreement between cytological and histopathological diagnoses.

Based on these findings, FNAC can be considered a highly effective, minimally invasive, rapid, and cost-efficient diagnostic tool in the evaluation of salivary gland lesions. Its ability to distinguish inflammatory lesions from neoplasms and benign tumours from malignant tumours provides valuable information for preoperative planning and patient management. Nevertheless, histopathological examination remains indispensable for definitive diagnosis, particularly in lesions with overlapping cytological features or atypical presentations.

Strengths of the Study

1. The study was conducted prospectively over a defined one-year period.
2. Both neoplastic and non-neoplastic salivary gland lesions were included, providing a comprehensive overview of disease patterns.
3. Histopathological correlation was available in a substantial proportion of cases, allowing objective assessment of diagnostic efficacy.
4. Diagnostic performance was evaluated using standard statistical parameters including sensitivity, specificity, predictive values, diagnostic accuracy, and kappa coefficient.
5. The study provides valuable regional data from Northeast India, where published literature on salivary gland cytopathology remains limited.

Limitations of the Study

1. The study was conducted at a single tertiary care centre, limiting generalizability to other populations.
2. The sample size was relatively small, particularly for malignant lesions.
3. Histopathological correlation was available in only 34 cases, which may have influenced statistical estimates.
4. The study duration was limited to one year.
5. Advanced ancillary diagnostic techniques such as immunocytochemistry and molecular studies were not routinely available for difficult cases.

Clinical Implications

The findings of the present study have important implications for clinical practice:

1. FNAC should be considered the first-line diagnostic investigation for patients presenting with salivary gland swellings.
2. High specificity and positive predictive value make FNAC particularly useful in identifying malignant lesions and guiding surgical planning.
3. Early cytological diagnosis can reduce patient anxiety and facilitate timely intervention.
4. Accurate identification of inflammatory and reactive lesions may prevent unnecessary surgical procedures.
5. FNAC is especially valuable in resource-limited healthcare settings because of its low cost, rapid turnaround time, and minimal invasiveness.
6. Close clinicoradiological correlation remains essential for maximizing diagnostic accuracy.
7. Histopathological confirmation should always be sought in surgically excised lesions and in cases demonstrating atypical cytological findings.

Recommendations for Future Research

1. Larger multicentric studies should be undertaken to validate the findings of the present study.
2. Long-term follow-up studies are required to assess the prognostic implications of cytological diagnosis.

3. Incorporation of the Milan System for Reporting Salivary Gland Cytopathology may further improve diagnostic standardization.
4. Future studies should evaluate the role of immunocytochemistry and molecular markers in diagnostically challenging lesions.
5. Comparative studies involving FNAC, core needle biopsy, and imaging modalities may provide additional insight into optimal diagnostic strategies.

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