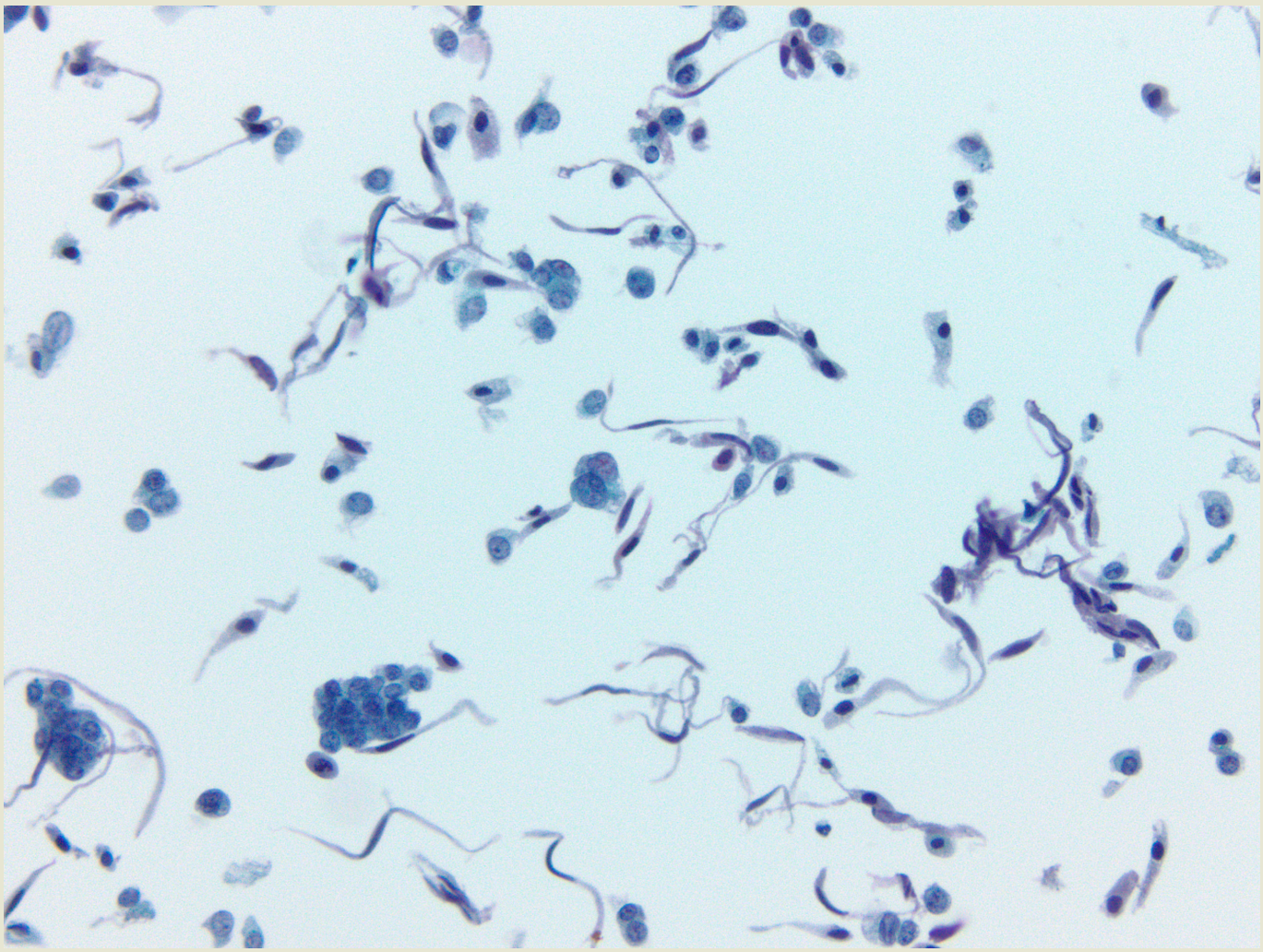
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Diagnostic Cytopathology

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Articles Accepted for Publication in Future Issues

Brian A. Pedro, Iiris Harjunpää, Eric Young, Leili Mirsadraei, Ivana Kholová, Zahra Maleki	Squamous Cells in Thyroid Cytology and Their Clinical Significance: A Multi-Institutional Study
Saroja Devi Geetha, Priyanka Karam, Yonah Ziemba, Karen Chau, Deepika Savant, Oana Rosca, Seema Khutti, Cecilia Gimenez, Kasturi Das	Correlation of Cytologic Features With Molecular Testing of Indeterminate Oncocytic (Hürthle Cell) Thyroid Lesions
Immacolata Cozzolino, Andrea Ronchi, Marco Montella, Raffaella Ruggiero, Rosaria Cappiello, Giovanni Savarese, Giuseppe Colella, Renato Franco	Application of Human Papillomavirus-DNA Test on Salivary Gland Fine Needle Aspiration Cytology Samples Confirms the Absence of the Virus in Primary Neoplasms and Demonstrates for the First Time Its Presence in Salivary Intraglandular Cysts
Fatih Mutlu, Busra Yaprak Bayrak, Murat Ozturk	Enhancing Diagnostic Precision and Clinical Outcomes With FNAC in Parotid Gland Masses

Cover legend: Singly dispersed spindled cells with delicate to wispy bipolar cytoplasm and elongated hyperchromatic nuclei (Papanicolaou stain, ×10).

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MEDICAL LABORATORY TECHNOLOGY

PATHOLOGY

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2024 JOURNAL IMPACT FACTOR

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View calculation

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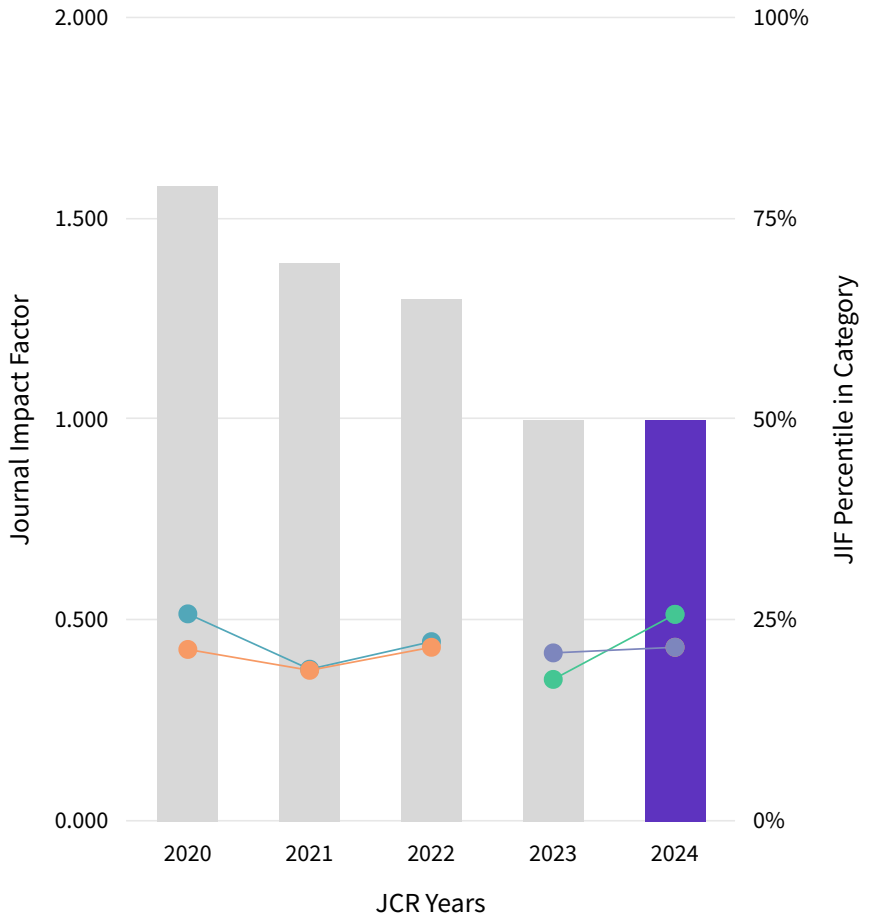
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Journal Impact Factor contributing items

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Citable items (283) Citing Sources (118)

TITLE	CITATION COUNT
Molecular/biomarker testing in lung cytology: A practical approach	6
Ancillary studies on cell blocks from fine needle aspiration specimens of salivary…	5



Criteria for follow-up of thyroid nodules diagnosed as follicular neoplasm witho…	5
Salivary gland neoplasms with basaloid features in the era of the Milan system f…	5
TRPS1 outperforms GATA3 in pleural effusions with metastatic breast…	5
Cervicovaginal cytology, HPV testing and vaginal flora in transmasculine persons…	4
EBUS ROSE-guided cytological evaluations of intrathoracic lesions.…	4
Hurthle cell-predominant thyroid fine needle aspiration cytology: A four risk-…	4
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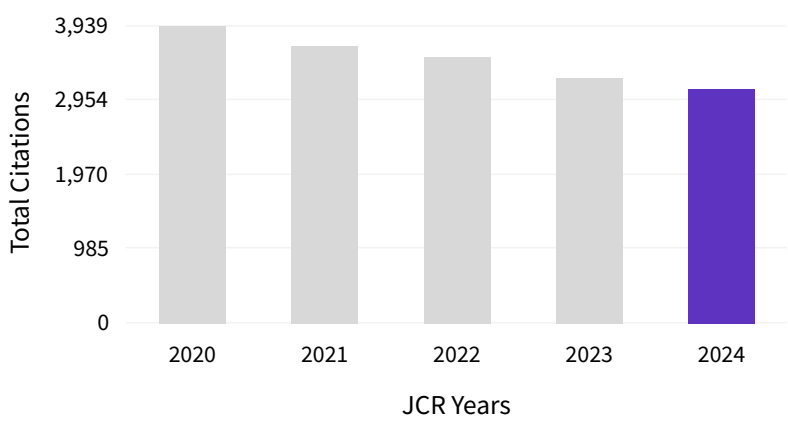
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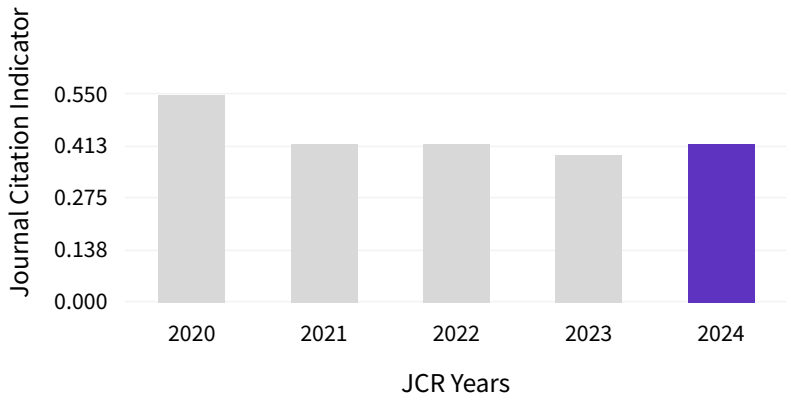
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15



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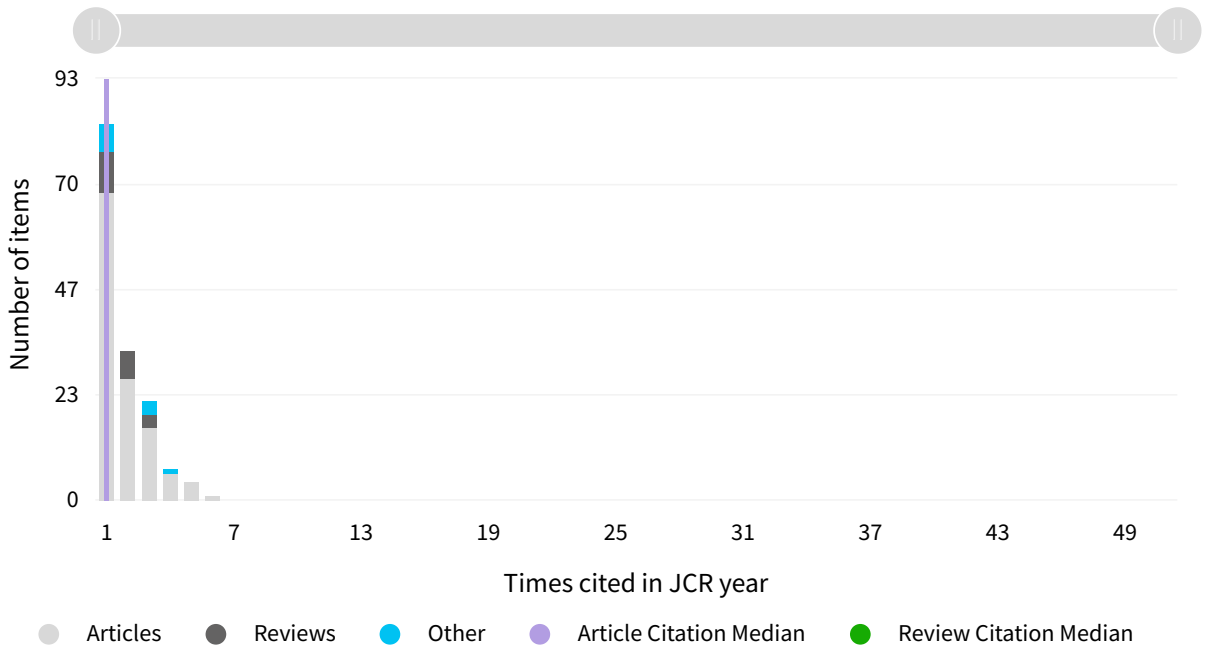
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UNLINKED CITATIONS

0



TIMES CITED

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ARTICLES

122

REVIEWS

21

OTHER

25

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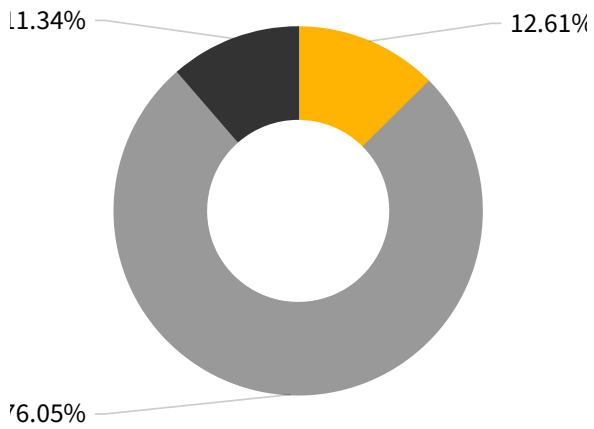
TOTAL CITABLE	% OF CITABLE OA
273	24.91%

15

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SUBSCRIPTION AND FREE TO READ
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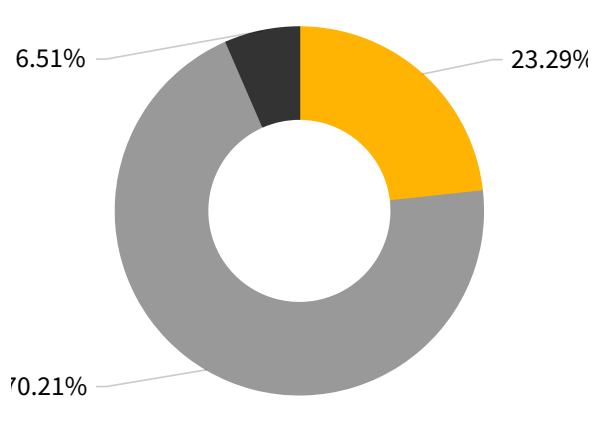
NON-CITABLE

OTHER (NON CITABLE ITEMS)
54 / 11.34%

CITABLE

GOLD OPEN ACCESS
68 / 23.29%

SUBSCRIPTION AND FREE TO READ
205 / 70.21%



NON-CITABLE

OTHER (NON CITABLE ITEMS)
19 / 6.51%

UNLINKED CITATIONS
0 / 0.00%

*Citations in 2024 to items published in [2022 - 2024]

Rank by Journal Impact Factor

Journals within a category are sorted in descending order by Journal Impact Factor (JIF) resulting in the Category Ranking below. A separate rank is shown for each category in which the journal is listed in JCR. Beginning in 2023, ranks are calculated by category.
Learn more

CATEGORY
MEDICAL LABORATORY TECHNOLOGY

25/33

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2024	25/33	Q4	25.8
2023	26/31	Q4	17.7

CATEGORY
PATHOLOGY

71/90

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2024	71/90	Q4	21.7
2023	70/88	Q4	21.0

Rank by JIF before 2023 for MEDICAL LABORATORY TECHNOLOGY

EDITION
Science Citation Index Expanded (SCIE)

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2022	23/29	Q4	22.4
2021	24/29	Q4	18.97
2020	22/29	Q4	25.86
2019	21/29	Q3	29.31

Rank by JIF before 2023 for PATHOLOGY

EDITION
Science Citation Index Expanded (SCIE)

JCR YEAR	JIF RANK	JIF QUARTILE	JIF PERCENTILE
2022	60/76	Q4	21.7
2021	63/77	Q4	18.83
2020	61/77	Q4	21.43
2019	60/78	Q4	23.72

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CATEGORY

MEDICAL LABORATORY TECHNOLOGY

26/33

JCR YEAR	JCI RANK	JCI QUARTILE	JCI PERCENTILE
2024	26/33	Q4	22.73
2023	25/31	Q4	20.97
2022	25/32	Q4	23.44
2021	25/33	Q4	25.76
2020	21/33	Q3	37.88
2019	21/33	Q3	37.88
2018	20/32	Q3	39.06

CATEGORY

PATHOLOGY

67/90

JCR YEAR	JCI RANK	JCI QUARTILE	JCI PERCENTILE
2024	67/90	Q3	26.11
2023	68/88	Q4	23.30
2022	62/87	Q3	29.31
2021	65/89	Q3	27.53
2020	55/90	Q3	39.44
2019	59/89	Q3	34.27
2018	61/89	Q3	32.02

Citation network

Cited Half-life

9.2 years

The Cited Half-Life is the median age of the items in this journal that were cited in the JCR year. Half of a journal's cited items were published more recently than the cited half-life.

TOTAL NUMBER OF CITES

3,109

NON SELF-CITATIONS

2,797

SELF-CITATIONS

312

Citing Half-life

7.9 years

The Citing Half-Life is the median age of items in other publications cited by this journal in the JCR year.

TOTAL NUMBER OF CITES

3,486

NON SELF-CITATIONS

3,174

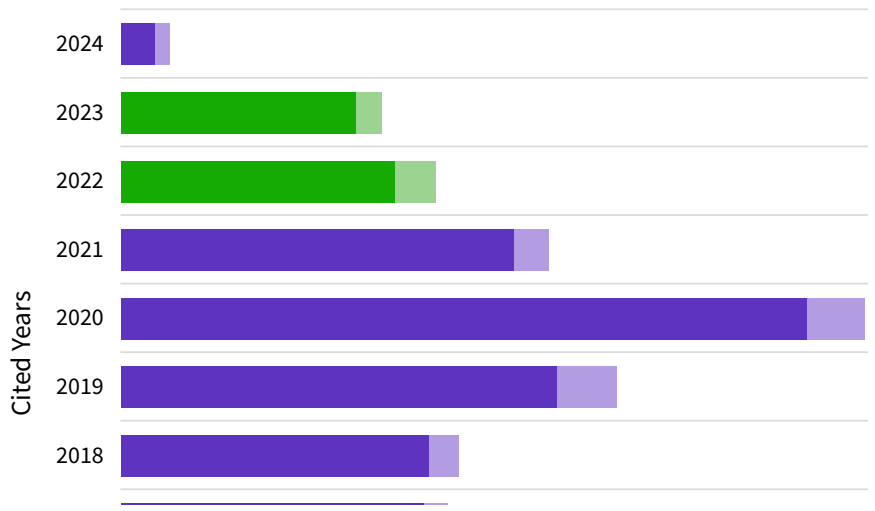
SELF-CITATIONS

312

Cited Half-life Data | Citing Half-life Data

Export

15

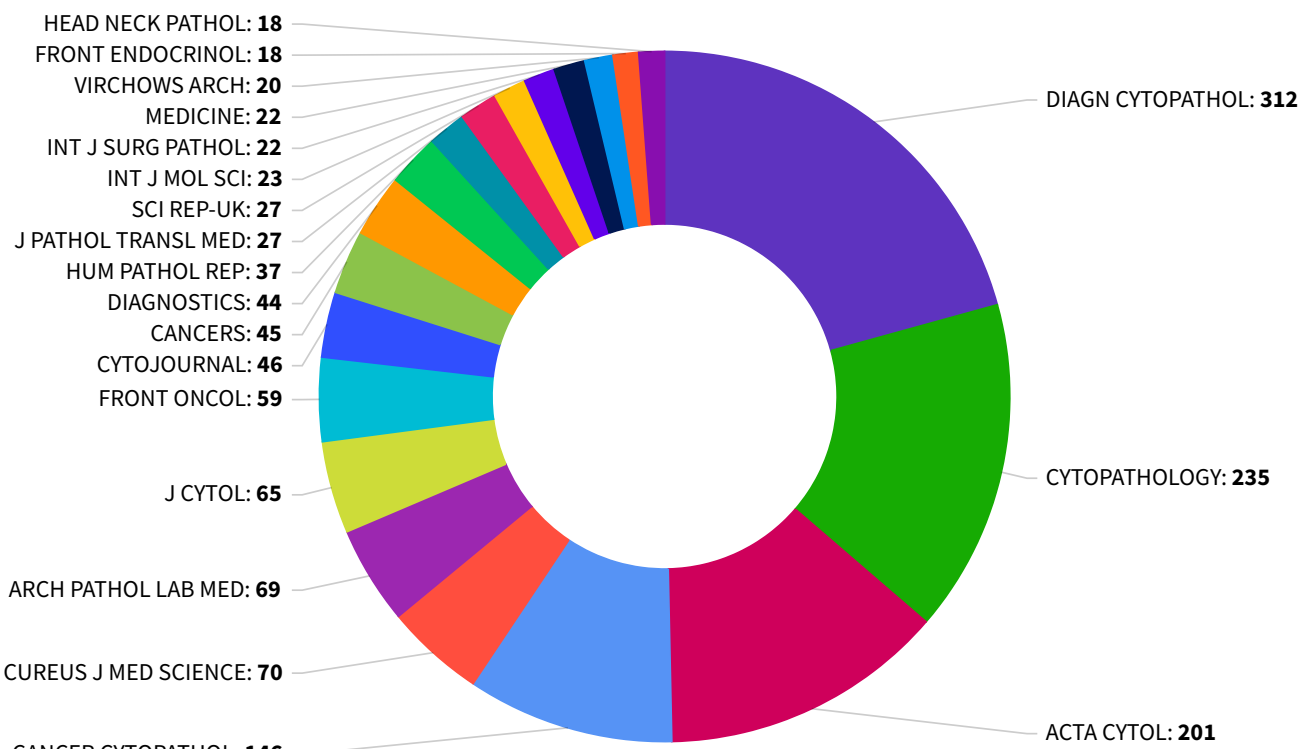


CITED YEAR	# OF CITES FROM 2024	CUMULATIVE %	# OF CITING SOURCES
All years	**3,109 citations**	**100.00%**	**719 sources**
2024	23 citations	0.74%	13 sources
2023	122 citations	4.66%	71 sources
2022	147 citations	9.39%	75 sources
2021	200 citations	15.83%	110 sources
2020	348 citations	27.02%	160 sources
2019	232 citations	34.48%	111 sources
2018	158 citations	39.56%	102 sources

Journal Citation Relationships

Cited Data Citing Data

Top 20 journals citing DIAGN CYTOPATHOL by number of citations



Content metrics

Source data

This tile shows the breakdown of document types published by the journal. Citable Items are Articles and Reviews. For the purposes of calculating JIF, a JCR year considers the publications of that journal in the two prior years. Learn more

Average JIF Percentile

Export

The Average Journal Impact Factor Percentile takes the sum of the JIF Percentile rank for each category under consideration 15 then calculates the average of those values. Learn more

139 total citable items

	ARTICLES	REVIEWS	COMBINED(C)	OTHER DOCUMENT TYPES(O)	PERCENTAG
NUMBER IN JCR YEAR 2024 (A)	125	14	139	19	88%
NUMBER OF REFERENCES (B)	2,789	592	3,381	105	97%
RATIO (B/A)	22.3	42.3	24.3	5.5	

ALL CATEGORIES AVERAGE
23.8

MEDICAL LABORATORY TECHNOLOGY
25.8

PATHOLOGY
21.7

Contributions by organizations

Export

Organizations that have contributed the most papers to the journal in the most recent three-year period. Learn more

RANK	ORGANIZATION	COUNT
1	POST GRADUATE INSTITUTE OF MEDICAL EDUCATION & RESEARCH (PGIMER), CHANDIGARH	30
2	UNIVERSITY OF TEXAS SYSTEM	16
3	CLEVELAND CLINIC FOUNDATION	14
-	PENNSYLVANIA COMMONWEALTH SYSTEM OF HIGHER EDUCATION (PCSHE)	14
-	UNIVERSITY SYSTEM OF OHIO	14

Contributions by country/region

Export

Countries or Regions that have contributed the most papers to the journal in the most recent three-year period. Learn more

RANK	COUNTRY / REGION	COUNT
1	USA	178
2	INDIA	118
3	JAPAN	38
4	CHINA MAINLAND	35
5	TURKIYE	25
6	SPAIN	11
7	ITALY	10
8	BRAZIL	8
-	PORTUGAL	8

Additional metrics

Eigenfactor Score

0.00212

The Eigenfactor Score is a reflection of the density of the network of citations around the journal using 5 years of cited content as cited by the Current Year. It considers both the number of citations and the source of those citations, so that highly cited sources will influence the network more than

Normalized Eigenfactor

0.47546

The Normalized Eigenfactor Score is the Eigenfactor score normalized, by rescaling the total number of journals in the JCR each year, so that the average journal has a score of 1. Journals can then be compared and influence measured by their score relative to 1. Learn more

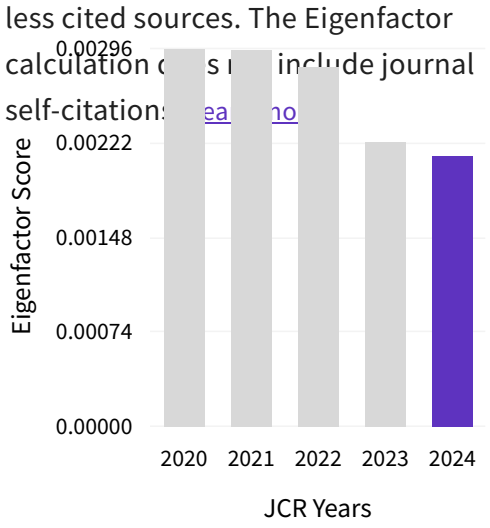
Article influence score

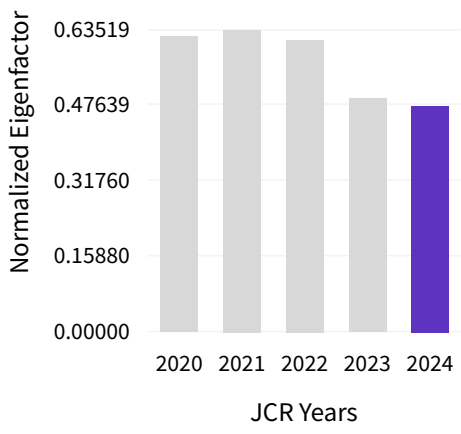
0.286

The Article Influence Score normalizes the Eigenfactor Score according to the cumulative size of the cited journal across the prior five years. The mean Article Influence Score for each article is 1.00. A score greater than 1.00

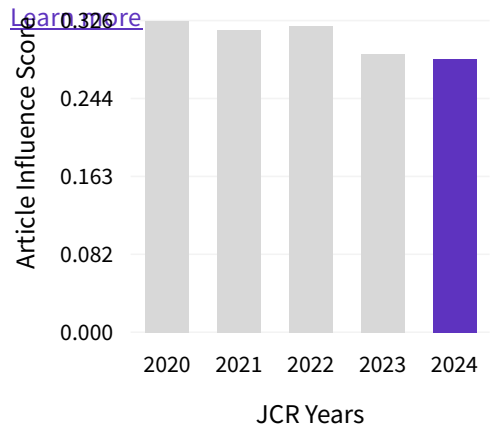
15

less cited sources. The Eigenfactor calculation does not include journal self-citations. Learn more





indicates that each article in the journal has above-average influence. Learn more

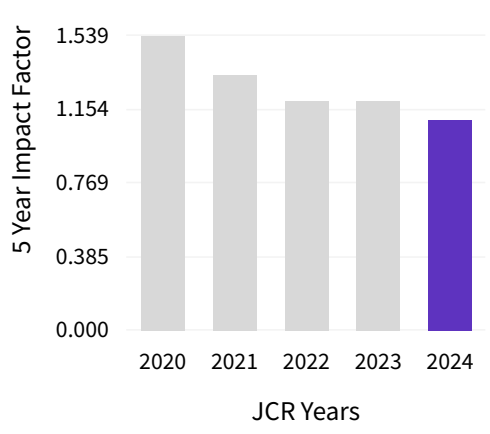


5 Year Impact Factor

1.1

View Calculation

The 5-year Impact Factor is the average number of times articles from the journal published in the past five years have been cited in the JCR year. It is calculated by dividing the number of citations in the JCR year by the total number of articles published in the five previous years. Learn more

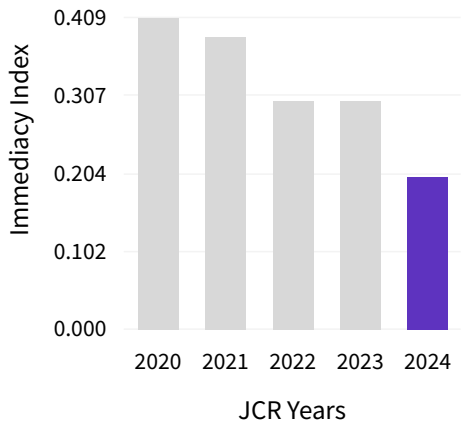


Immediacy Index

0.2

View Calculation

The Immediacy Index is the count of citations in the current year to the journal that reference content in this same year. Journals that have a consistently high Immediacy Index attract citations rapidly. Learn more



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ORIGINAL ARTICLE

Enhancing Diagnostic Precision and Clinical Outcomes With FNAC in Parotid Gland Masses

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Keywords: cytology | diagnostic accuracy | malignancy | parotid gland | salivary gland masses

ABSTRACT

Background: Parotid gland masses encompassing both neoplastic and non-neoplastic conditions present diagnostic challenges. Fine-needle aspiration cytology (FNAC) is commonly used to differentiate between benign and malignant lesions but has limitations such as variable sensitivity and potential sampling errors. This study assesses FNAC's accuracy for parotid gland lesions, evaluates the Milan Salivary Gland Cytopathology Reporting System (MSRSGC), and compares FNAC results with histopathological findings.

Methods: This retrospective study at our medical center analyzed data from 2321 patients who underwent parotid gland FNAC followed by surgical resection over 20 years. Patients were included if they had both cytological analysis and surgery between January 2004 and July 2024. Surgical procedures varied based on mass characteristics and FNAC results, and all samples were assessed using MSRSGC. Statistical analysis compared FNAC results with histopathology findings, calculating sensitivity, specificity, and accuracy.

Results: This study included 352 patients who underwent both FNAC and surgical resection. FNAC had an overall accuracy of 93.9%, with a sensitivity of 78.3% and specificity of 91.5%. The risk of malignancy was 30% for Milan Category I (nondiagnostic), 6.3% for Category II (non-neoplastic), 0% for Category III (Atypia of Undetermined Significance), 2.3% for Category IVa (benign neoplasm), 5.8% for Category IVb (neoplasm of uncertain malignant potential), 58.8% for Category V (suspicious for malignancy), and 95% for Category VI (malignant). The false negative rate was 2.4%, while the false positive rate was 3.4%. The malignancy risk increased with age, and malignant masses were larger and more likely to cause facial paralysis.

Conclusion: FNAC is a key diagnostic tool for parotid gland masses, offering high specificity and accuracy despite some limitations. Patients with young ages and inappropriate histories should be assessed more carefully. MSRSGC is a useful system to show appropriate risk of malignancy.

1 | Introduction

Parotid gland masses encompass a wide spectrum of neoplastic and non-neoplastic entities but are more likely to be neoplastic [1, 2]. The parotid gland is the largest of all salivary glands, accounting for 75%–80% of all salivary gland masses. Of these lesions, 80% are benign and 20% are malignant, and both benign and malignant lesions present as swellings or masses in the subauricular region, presenting significant diagnostic challenges [2]. In addition to these primary tumors, a variety of metastatic neoplasms may be found in the intraparotid lymph nodes. Conditions such as reactive lymph node enlargement,

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sialolithiasis, sialadenitis, sialometaplasia, and cysts may also present as parotid gland masses [3]. Given the potential implications for treatment planning and patient outcome, accurate diagnosis is crucial in the preoperative setting.

Fine-needle aspiration cytology (FNAC) is a widely used, minimally invasive cytodiagnostic technique for the evaluation of parotid gland lesions. This method involves the evaluation of cells, cell clusters, and tissue microparticles and is considered more diagnostic for salivary gland masses than physical examination or radiologic evaluations [3, 4]. FNAC provides valuable information to determine whether a lesion is benign or malignant and to guide the timing and extent of surgical intervention. However, the role of FNAC in the management of parotid gland lesions remains controversial; its low sensitivity and inconsistencies between cytology and biopsy results have led to questions about its clinical utility [4, 5]. Differentiating between some types of salivary gland tumors or between benign and malignant tumors may be difficult because of overlapping cellular features. Additional staining methods are often of limited help, and due to limitations of the technique, FNAC cannot evaluate malignant features such as invasive growth, perineural invasion, or vascular invasion. Furthermore, the risk of sampling error is a major concern, leading to possible misdiagnosis [6]. Some authors argue that preoperative FNAC is unnecessary because of the possibility of false positive and false negative results and the assumption of it is not changing the treatment approach, while others argue that it is necessary because it can change the surgical approach or its extensions or may lead to nonsurgical interventions for benign and malignant parotid masses [6–8].

Studies have shown that FNAC has an overall sensitivity of 78% and a specificity of 97.8% in diagnosing parotid gland lesions [8, 9]. Subgroup analysis for FNAC performed under ultrasound guidance showed a slight improvement in sensitivity and specificity rates [9]. However, despite these promising results, approximately 13.3% of FNAC results remain indeterminate or nondiagnostic [10]. FNAC is known to have a risk of misdiagnosis, especially in distinguishing certain tumor types and in cases where sampling errors occur.8 This leads to potential confusion for both patients and clinicians, especially regarding the risk of false negative results [11]. As a result, uncertainties remain regarding the reliability of FNAC results and the necessity of surgical intervention [12, 13]. To address these challenges, the Milan Salivary Gland Cytopathology Reporting System (MSRSGC) was introduced in 2018 with the support of the American Society of Cytopathology and the International Academy of Cytology [9]. The MSRSGC offers a more objective and reproducible approach to diagnosis using a categorical system. MSRSGC has been shown to contribute significantly to the management of parotid gland masses and increase the diagnostic accuracy of FNAC [8].

The aim of this study was to evaluate the diagnostic accuracy of FNAC for parotid gland lesions in our institution, to validate the use of MSRSGC classification in improving diagnostic results, and to compare FNAC results with final histopathological diagnoses. Additionally, we evaluated postoperative parameters and surgical outcomes by providing a comprehensive analysis of the clinical significance of FNAC in the management of parotid gland lesions. We contributed to the ongoing debate on diagnostic and therapeutic approaches for parotid gland masses in the current studies.

2 | Methods

2.1 | Study Group and Data Collection

This retrospective study was conducted at our medical center, where we collected data from patients who underwent parotid salivary gland aspiration followed by surgical resection over a 20-year period. The inclusion criteria for our study consisted of patients diagnosed with parotid gland masses who underwent both cytological analysis and surgical resection between January 2004 and July 2024. A total of 730 salivary gland surgeries were identified and analyzed. Patient demographic data, including age and gender, were retrieved from the hospital's electronic medical records. Malignancy risk was compared according to age (<55 vs. ≥ 55 years of age). Surgeries performed outside the salivary gland; surgeries involving the submandibular gland, sublingual gland, and minor salivary gland; patients who did not undergo preoperative FNAC and whose records could not be accessed were excluded from the study.

This study focuses exclusively on parotid gland FNAs, as the parotid gland is the most common site for salivary gland diagnostic procedures, and FNAs for this gland are more frequently performed in our institution. One of the key reasons for selecting parotid gland cases was to ensure that all tumors were fully resected, as tumors in some minor salivary glands may not be completely removed due to their location and proximity to vital organs and blood vessels. By focusing on parotid lesions, we ensured that both the FNAC results and resection data were available within our institution, and we selected only cases with complete follow-up information. We also compared our findings with other studies conducted on parotid gland FNAC in the literature. This approach helped to standardize our study population and allowed for a more accurate comparison of FNAC results with histopathology, avoiding potential biases from incomplete resection or follow-up in other salivary gland locations.

2.2 | Surgical Procedures

Patients with prominent, large, and superficial masses underwent preoperative FNAC performed by skilled otolaryngologists. In cases of small, deeply located, nonpalpable, or cystic masses, radiologist assistance was sought to ensure correct aspiration and to prevent inadequate aspiration. When the first pathology was identified as "non-diagnostic," a second fine needle aspiration was attempted. If the second sample was identified as nondiagnostic again, there was no third attempt; surgery was proposed to the patient. The type of surgical procedure (e.g., pericapsular, superficial, deep lobe, subtotal, total, or extended parotidectomy, and neck lymph node dissection) was determined by the nature of the mass, radiological findings (Figures 1 and 2), and FNAC results. We have grouped pericapsular, superficial, deep lobe, subtotal, etc. parotidectomies under the terminology of partial parotidectomy. Total parotidectomies, extended parotidectomy (+/−facial nerve resection), and neck dissection were also recorded separately.

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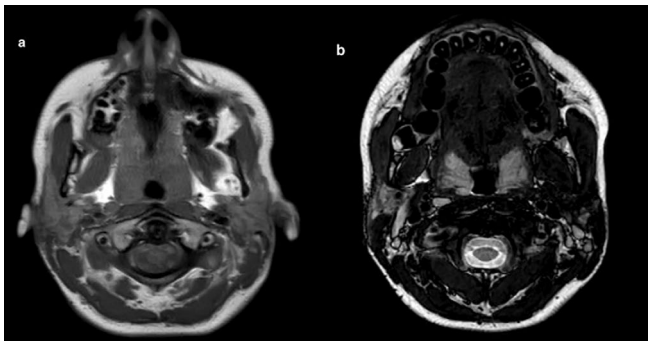


FIGURE 1 | MRI of acinic cell carcinoma right parotid gland. Hyperintense image in both T1 (a) and T2 (b) images.

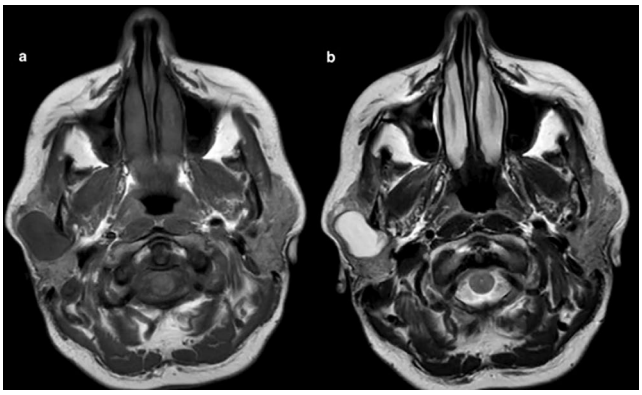


FIGURE 2 | MRI of schwannoma of the right parotid gland. A well-bounded, cystic mass. (a) T1-weighted (b) T2-weighted.

2.3 | Pathological Analysis

The aspirated samples were prepared on glass slides and stained accordingly. Diagnostic adequacy was assessed according to the quality and cellularity of FNAC samples. All FNAC cases were classified according to MSRSGC [8]. Cases initially not reported according to this system were re-evaluated and reclassified. According to this categorization, slides of nondiagnostic cases were reviewed, and the cause was investigated. Specific tumor types were recorded in patients with adequate cytologic smears. Histopathological examination was performed on resection samples by an experienced head and neck pathologist.

2.4 | Statistical Analysis

All statistical analyses were performed using IBM SPSS for Windows version 20.0 (IBM Corp., Armonk, NY, USA). Statistical analyses were performed to compare the preoperative FNAC results with the final histopathological findings. Descriptive statistics were determined as the mean, standard deviation, median, minimum, and maximum values for continuous variables and as percentages for categorical variables. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and likelihood ratios (LR+; LR−) were calculated. Sensitivity was determined by the ratio of positive cytological findings relative to the total number of histologically confirmed malignancies. Specificity was calculated as the ratio of histologically confirmed benign lesions against all negative FNAC results. The accuracy of the diagnostic method was derived from the total number of confirmed benign and malignant tumors against the overall number of cases. Statistical analyses were conducted using software to ensure the reliability of the results, and corresponding 95% confidence intervals (CIs) for each measure were reported. $p < 0.05$ value was considered statistically significant.

3 | Results

3.1 | Demographic, Clinical, and Treatment Characteristics

Out of the initial 360 patients with salivary gland masses, 18 were excluded due to incomplete preoperative data, leaving a total of 352 patients who underwent both FNAC and surgery. The cohort was almost evenly split by age, with 63.1% of patients under 55 years old and 36.9% aged 55 years or older. Gender distribution was also balanced, with 50.8% male and 49.2% female patients. Most parotid masses (55.7%) were located in the right parotid gland, and the mean tumor diameter was 31.8 ± 13.9 mm, with benign tumors averaging 31.2 ± 13.3 mm and malignant tumors averaging 36.6 ± 16.6 mm.

Partial parotidectomy was the most common surgical procedure, performed in 81.6% of cases. This included 86.6% of benign cases and 51.2% of malignant cases diagnosed by FNAC. Extended parotidectomy was conducted in 9.8% of malignant cases, with one involving facial nerve resection. Nineteen patients with malignancy detected by FNAC had palpable lymph nodes; in these cases, simultaneous FNAC of the lymph nodes was performed, resulting in seven confirmed metastases. Neck dissection was carried out during the first surgery for these patients. Two additional patients required secondary neck dissection due to occult metastasis discovered in final pathology results.

Preoperative facial nerve paralysis was present in 3.1% of patients (11 cases), 10 of which were associated with malignant masses. Following surgery, patients with positive surgical margins or lymph node metastasis were evaluated by a multidisciplinary oncology council, with 5.1% receiving radiotherapy and 4.0% undergoing chemoradiotherapy. The median follow-up duration for all patients was 30 months, ranging from 2 to 162 months.

3.2 | Surgical Procedures

Surgical interventions included partial parotidectomy in 287 cases (81.6%) of both benign (86.6%) and malignant cases (51.2%) diagnosed by FNAC. Extended parotidectomy was performed in 4 cases (9.8%) (one with facial nerve resection, three without facial nerve resection) with malignant FNAC results. Nineteen patients with malignancy detected by FNAC had palpable neck lymph nodes. Simultaneous FNAC was performed on these lymph nodes. Since these lymph nodes were reported as carcinoma metastasis, these patients underwent neck dissection

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during the first surgery. Seven of these 19 patients had metastatic lymph nodes. Secondary neck dissection was performed on two patients due to permanent pathology results that were benign on FNAC but malign on final pathology with a high-risk occult metastasis potential.

There were 11 facial nerve paralysis, preoperatively (3.1%). Five patients were classified as House-Brackmann (HB) grade VI, indicating total facial paralysis with no movement. Four patients were classified as HB grade III, showing moderate dysfunction with obvious but not disfiguring asymmetry and complete eye closure with effort. Two patients were classified as HB grade II, with slight dysfunction, including mild weakness noticeable only upon close inspection, and complete eye closure with minimal effort. After the surgery and final pathologic examination, ten of the facial paralyses existed in the malignant cases and one in the benign case. After surgery and pathological examination, patients with malignant tumor type and positive surgical margins or metastatic lymph nodes were assessed in a multidisciplinary oncology council. Chemotherapy and/or radiotherapy was proposed to the appropriate patients. 5.1% of the patients received radiotherapy and 4.0% received chemoradiotherapy. The follow-up period for all patients ranged from 2 to 162 months, with a median of 30 months.

3.3 | Malignancy Rates in Demographics, Clinical Features, and Treatments

In our study, the risk of malignancy according to age was 9.1% under 55 years of age and 16.9% at 55 years of age and above ($p < 0.05$). The malignancy rates were 14.0% in males and 10.4% in females, respectively ($p > 0.05$), with no significant difference. Malignant masses were significantly greater in size compared to benign ones ($p < 0.05$). Postoperative facial paralysis was observed to be statistically significant in malignant cases ($p < 0.001$).

3.4 | Cytopathological and Histopathological Correlation

The distribution of cytological and histopathological diagnoses of all patients is detailed in Table 1. Although 20 of 352 patients were included in Milan category 1 according to FNAC, these patients underwent surgery. The reason for this was the aesthetic concerns of some of these patients due to the size of the lesion, the presence of a fixed mass, a clinically and radiologically highly probable tumor suspicion, or the presence of palpable lymph nodes. The malignancy rate in these patients was determined to be 30%. For the 252 cases in Milan Category IVa, the malignancy risk rate was 2.3%, with six cases confirmed as malignant. Only one of the 17 cases in Milan Category IVb was malignant, resulting in a malignancy risk rate of 5.8%.

3.5 | Diagnostic Performance of FNAC

The diagnostic performance metrics of FNAC are presented in Table 2. The overall accuracy of FNAC was 93.9%, with a sensitivity of 78.3%, a specificity of 91.5%, a positive predictive value of 70.7%, and a negative predictive value of 97.3%. Of the 352 patients, 283 were true negative, 29 were true positive, 12 were false positive, and 8 were false negative.

3.6 | False Positive and False Negative Results

Table 3 summarizes the false positive and false negative results. Among the eight false negative cases, initial FNAC diagnoses included Warthin tumor, pleomorphic adenoma, abscess, and benign salivary gland neoplasm (Figures 3 and 4). However, the histopathological examinations revealed diagnoses such as mucoepidermoid carcinoma (MECa), mature B-cell lymphoma, acinic cell carcinoma, and carcinoma ex pleomorphic adenoma.

For the 12 false positive cases, FNAC initially suggested acinic cell carcinoma, suspected malignant salivary gland neoplasm, lymphoma, and thyroid papillary carcinoma metastasis, among others. However, histopathological findings included benign conditions such as schwannoma, myoepithelioma, reactive lymphoid hyperplasia, Warthin tumor, branchial cyst, and pleomorphic adenoma.

4 | Discussion

Our study underscores the utility of FNAC in the evaluation of parotid gland masses, particularly in distinguishing between benign and malignant lesions. With an overall accuracy rate of 93.9%, FNAC proved to be a reliable diagnostic tool, though challenges such as false positive and false negative results highlight the inherent limitations of this technique. The risk of malignancy (ROM) was found to increase with age, particularly in patients over 55, and malignant masses tended to be larger and more likely to result in postoperative facial paralysis. The majority of patients underwent partial parotidectomy, with neck dissections performed when lymph node metastasis was identified preoperatively. While FNAC's sensitivity was lower than its specificity, the high negative predictive value demonstrates its effectiveness in ruling out malignancy in most cases. However, the presence of diagnostic discrepancies in certain categories, such as cystic lesions and non-neoplastic entities, emphasizes the need for careful clinical and radiological correlation to enhance diagnostic precision.

Salivary gland tumors most commonly arise in the parotid gland, with the majority being benign, such as pleomorphic adenomas and Warthin's tumors [6, 9, 11]. In our study, the most common malignancies were MECa and acinic cell carcinoma, which align with previously reported trends [6, 9, 11]. While the incidence is slightly higher in men [8], our findings reaffirm that patients over 55 years old are at greater risk for malignancies in parotid masses.

MSRSGC provides a structured framework for classifying salivary gland lesions, helping to standardize diagnostic reporting. However, certain diagnostic challenges persist, especially in distinguishing benign from malignant lesions [1, 8, 18, 19]. Our study revealed several discrepancies between cytological and histological diagnoses, underscoring the need for careful evaluation of certain categories.

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TABLE 1 | Distribution of cytological and histopathological diagnoses of the cases according to the Milan system.

MSRSGC	Cytopathological diagnosis ($N=352$)	Histopathological diagnosis ($N=352$)	ROM	ROM as per MSRSGC [1, 10, 19]
Nondiagnostic-Category I ($n=20$)	Acellular (17), Cystic content (3)	WT (5), PA (4), Ductus cyst (1), Dermoid cyst (1), Epidermoid cyst (1), Basal cell adenoma (1), Fibromatosis (1) **Basal Cell adenocarcinoma (2), Acinic cell carcinoma (1), MECa (1), Myoepithelial carcinoma (1), Malign melanoma metastasis (1)**	30%	25%
Nonneoplastic-Category II ($n=16$)	Chronic sialadenitis (8), Sialadenosis (1), Abscess (2), Reactive lymphadenopathy (5)	Abscess (2), Epidermoid cyst (3), Reactive Lymphoid Hyperplasia (6), Benign Lymphoepithelial cyst (3), PA (1) **MECa (1)**	6.3%	10%
AUS-Category III ($n=6$)	Lymphoepithelial cyst/ WT (6)	PA (3), WT (2), Reactive Lymphadenopathy (1)	0%	20%
Neoplasm-Benign-Category IVa ($n=252$)	PA (148), WT (98), Benign salivary gland tumor (6)	WT (92), PA (140), Benign Lymphoepithelial cyst (2), Bronchogenic cyst (1), Mucocele (1), Salivary ducts cyst (1), Schwannoma (2), Oncocytoma (2), Basal cell adenoma (1), Canalicular adenoma (1), Myoepithelioma (2) **MECa (2), Acinic Cell (2), Mature B-Cell Lymphoma (1), Carcinoma ex pleomorphic adenoma (1)**	2.3%	$<5\%$
Neoplasm-SUMP-Category IVb ($n=17$)	Salivary gland neoplasm (13), Basaloid neoplasm (2), Oncocytoma (2)	Basal cell adenoma (3), Oncocytoma (2), Lipoma (1), Monomorphic adenoma (1), PA (4), Sjögren (1), WT (4) **Acinic cell carcinoma (1)**	5.8%	35%
SM-Category V ($n=21$)	ACC/PLGA (4), suspicious for squamous cell carcinoma (4), suspicious for acinic cell carcinoma (4), suspicious for lymphoproliferative neoplasia (3), suspicious for adenocarcinoma (6)	WT (4), PA (4), Myoepithelioma (1), Reactive lymphadenopathy (1), Schwannoma (1) **Acinic cell carcinoma (2), Salivary gland adenocarcinoma (2), Basal cell adenocarcinoma (1), Lymphoepithelial carcinoma (1), MECa (1), Non-Hodgkin lymphoma (2), SCC (1)**	58.8%	60%
Malignant-Category VI ($n=20$)	**Malignant salivary gland neoplasm (2), ACC (4), MECa (5), Acinic cell carcinoma (2) Others[a] (7)**	Branchial cyst (1) **ACC (4), Acinic cell carcinoma (3), Basal cell adenocarcinoma (1), Carcinosarcoma (1), Malign melanoma metastasis (1), MECa (4), SCC (3), Salivary gland ductal carcinoma (2)**	95%	90%

Note: Malignant results are shown in bold characters.

Abbreviations: ACC: adenoid cystic carcinoma, AUS: atypia of undetermined significance, EMC: epithelial myoepithelial carcinoma, LEL: lymphoepithelial lesion, MECa: mucoepidermoid carcinoma, MSRSGC: Milan system for reporting salivary gland cytopathology, PA: pleomorphic adenoma, PLGA: polymorphous low-grade adenocarcinoma, ROM: risk of malignancy, SFM: suspicious for malignancy, SUMP: salivary gland neoplasm of uncertain malignant potential, WT: Warthin's tumor.

[a]Others: adenocarcinoma, squamous cell carcinoma.

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In category I (nondiagnostic), the majority of cases (85%) were acellular, and histopathological diagnoses included benign tumors such as Warthin tumors and pleomorphic adenomas. However, the 30% ROM in our study was higher than the MSRSGC benchmark, likely due to misclassification of cystic lesions. This highlights a diagnostic pitfall where cystic components or insufficient sampling can lead to inaccurate categorization.

We classified 16 cases as Milan Category II (non-neoplastic) according to FNAC. Histopathological analysis revealed that one case was diagnosed as MECa and another as pleomorphic adenoma. The ROM for Category II cases in our study was calculated at 6.3%, which is lower than the ROM typically reported in broader studies involving multiple salivary glands [1, 8, 18, 19]. However, this lower ROM in our study likely reflects the fact that we exclusively examined parotid gland FNAs, where the incidence of malignancy in non-neoplastic lesions tends to be lower compared to other salivary glands. The reduced ROM in our findings suggests that FNAC is effective in ruling out malignancy in non-neoplastic parotid lesions, which is consistent with the predominantly benign nature of parotid gland masses.

Atypia of Undetermined Significance (AUS) cases (Category III) showed no malignancies, and our 0% ROM was notably lower than the 20% suggested by MSRSGC. Sampling variability could explain this discrepancy, but it emphasizes the need for a cautious approach in AUS cases, especially in instances of persistent clinical or radiological suspicion. While the MSRSGC suggests a higher ROM [8], our findings align more closely with the benign nature of the lesions identified in this category. Despite the lower ROM, careful consideration should be given to the management of AUS cases, including the potential need for repeating FNA or surgical intervention in cases with persistent clinical or radiological suspicion [9, 18, 19].

Category IVA showed predominantly benign lesions, with a ROM of 2.3%, consistent with the MSRSGC's expected < 5%. However, the presence of malignancies such as MECa and acinic cell carcinoma demonstrates the importance of vigilance when interpreting cytological features, as some malignancies can present with subtle cytological changes. While the majority of cases in category IVA tend to be accurately diagnosed due to their distinct cytological features, the presence of malignancies underscores the importance of cautious interpretation and, when necessary, follow-up procedures to ensure accurate diagnosis [9, 10, 19].

SUMP (Category IVB) had a surprisingly low ROM of 5.8%, much lower than the 35% ROM expected [8]. This could be partially attributed to the higher likelihood of benign lesions in

TABLE 2 | Diagnostic sensitivity, specificity, accuracy, and predictive values of fine needle aspiration cytology ($N = 332$).

Parameters	Parotid gland (%)
True positive ($n = 29$)	8.7
True negative ($n = 283$)	85.2
False positive ($n = 12$)	3.6
False negative ($n = 8$)	2.4
Accuracy ([TP + TN]/[TP + TN + FP + FN])	93.9
Sensitivity (TP/[TP + FN])	78.3
Specificity (TN/[FP + TN])	91.5
Positive predictive value (TP/[TP + FP])	70.7
Negative predictive value (TN/[TN + FN])	97.3

Abbreviations: FN: false negative; FP: false positive; TN: true negative; TP: true positive.

TABLE 3 | False positive and false negative results of fine needle aspiration cytology ($n = 20$).

False negative ($n = 8$)		False positive ($n = 12$)	
Cytological diagnosis	**Histopathological diagnosis**	**Cytological diagnosis**	**Histopathological diagnosis**
Warthin's tumor (3)	MECa (1) Mature B-Cell lymphoma (1) Acinic cell carcinoma (1)	Acinic cell carcinoma? (2)	Schwannoma (1) Myoepithelioma (1)
Pleomorphic adenoma (3)	MECa (1) Acinic cell carcinoma (1) Carcinoma ex pleomorphic adenoma (1)	Lymphoma? (1)	Reactive lymphoid hyperplasia (1)
Abscess (1)	MECa (1)	Thyroid papillary carcinoma? (1)	WT (1)
Benign salivary gland neoplasm (1)	Acinic cell carcinoma (1)	Malign salivary gland neoplasm? (2)	PA (2)
		MECa? (1)	Branchial cyst (1)
		PLGA? (1)	PA (1)
		ACC? (1)	PA (1)

Abbreviations: ACC: adenoid cystic carcinoma; MECa: mucoepidermoid carcinoma.

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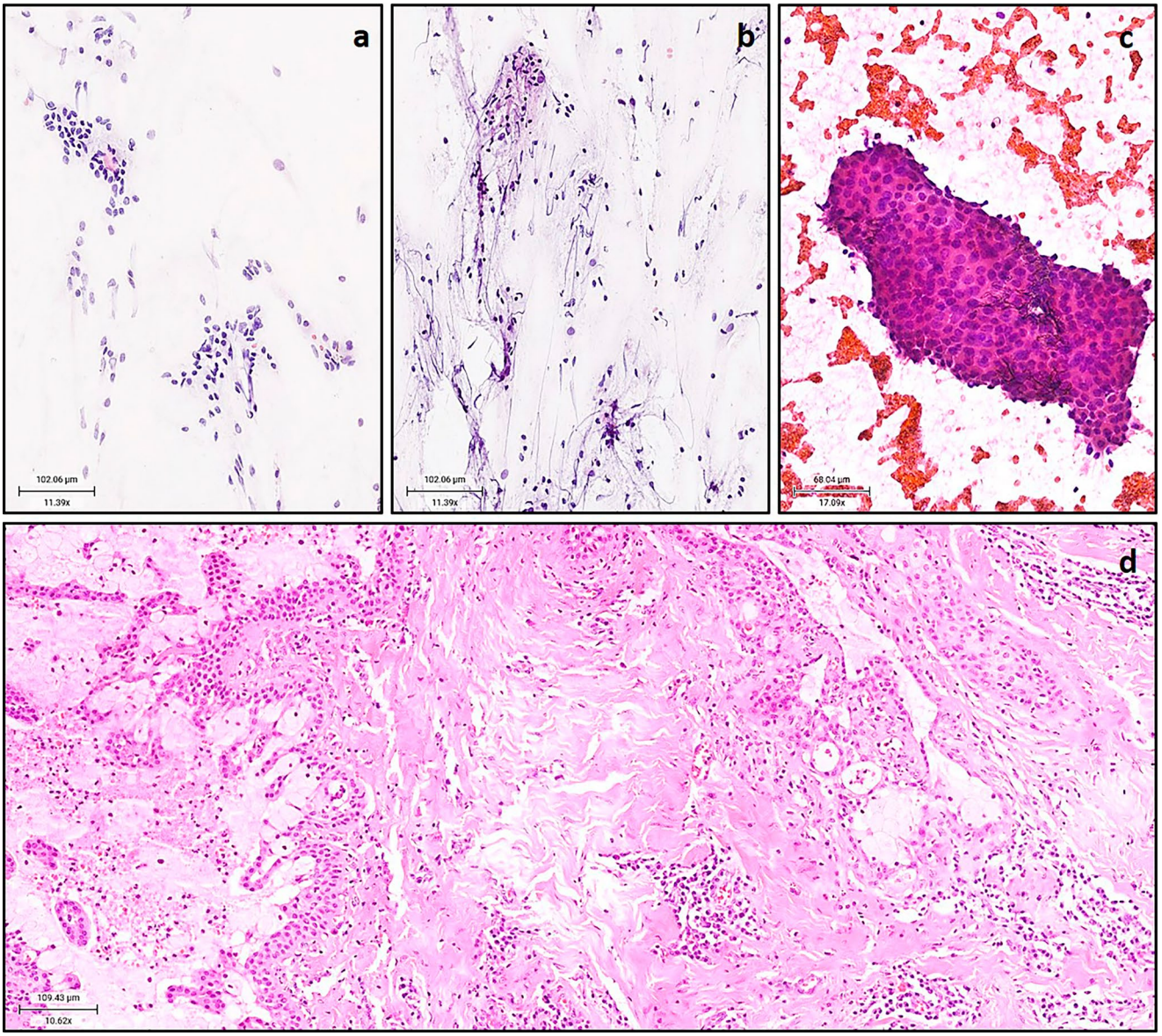


FIGURE 3 | Cytological images (a–c) suggestive of pleomorphic adenoma with scattered myoepithelial and ductal epithelial cells in a fibrillary stroma, but histopathology (d) reveals a diagnosis of mucoepidermoid carcinoma, highlighting a false negative case. [Color figure can be viewed at wileyonlinelibrary.com]

parotid gland FNAs. Additionally, the cytopathologist's diagnostic preference may have influenced the limited use of the SUMP category, as they might have opted for more definitive categorizations based on the available cytological and clinical data. This could explain the infrequent use of this category in our cohort. Nonetheless, clinicians must remain alert to the potential for malignancies in cases classified under this category, particularly when clinical findings suggest otherwise. While MSRSGC recommends a cautious approach for cases in this category due to the potential for malignancy [8, 9], our findings suggest that the actual risk may vary considerably depending on the specific patient population and diagnostic context.

In categories V and VI, the ROM closely matched MSRSGC predictions [8, 9, 18, 19], with 58.8% and 95%, respectively. These categories primarily include cases with a high suspicion of malignancy, and the accuracy of FNAC in these cases is critical. However, diagnostic pitfalls remain, particularly in differentiating low-grade mucoepidermoid carcinomas from benign lesions such as pleomorphic adenomas. In three cases, deep-seated tumors were misdiagnosed as benign, highlighting the challenges of accurate sampling in these lesions. A careful approach is required when evaluating cases in Categories V and VI, and the high risk of malignancy in patients classified under these categories should be considered.

FNAC is widely recognized as a valuable tool for differentiating benign from malignant parotid gland lesions, as supported by various studies highly dependent on the skill and experience of the pathologist, and challenges persist in diagnosing certain tumors, particularly pleomorphic adenoma, basal cell adenoma, low-grade mucoepidermoid carcinoma, and acinic cell carcinoma [6, 8–11]. Our analysis found a 2.4% false-mucoepidermoid carcinoma often misclassified due to

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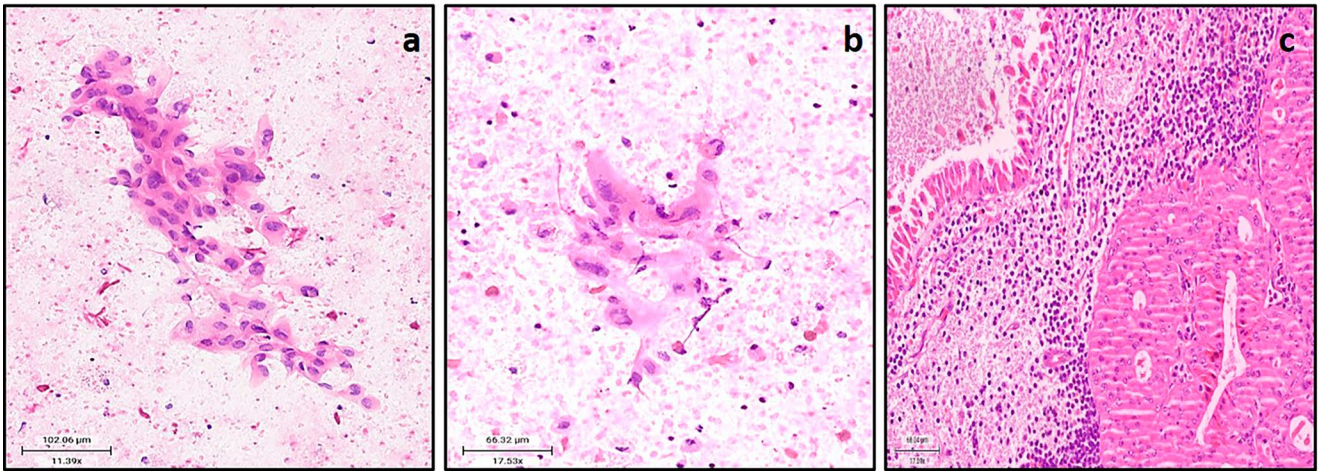


FIGURE 4 | Cytological images (a, b) with atypical squamous-like cell clusters in a necrotic background, leading to an initial false positive diagnosis of squamous cell carcinoma. However, histopathology (c) reveals the presence of Warthin tumor, characterized by oncocytic epithelial cells and lymphoid stroma, correcting the initial diagnosis. [Color figure can be viewed at wileyonlinelibrary.com]

thick mucinous material and sparse cellularity. Warthin tumors and pleomorphic adenomas were frequently misclassified as benign and later identified as lymphoma, a common pitfall in distinguishing lymphoproliferative processes. These diagnostic errors can result in limited surgical intervention, complicating further surgeries, especially due to the risk of facial nerve damage [19, 21]. Clinicians should take particular care in cases that deviate from the expected demographic or clinical patterns, ensuring thorough evaluation with clinical, radiological, and histopathological correlation when malignancy is suspected.

The role of FNAC in surgical planning is indispensable, particularly in differentiating benign from malignant lesions preoperatively [5–12]. Accurate cytological diagnoses can help avoid unnecessary surgery or guide more extensive resections when malignancy is suspected. Well-designed studies showed that FNAC sensitivity and specificity ranged from 65% to 95% and 82% to 100%, respectively, and the number of patients included in these studies ranged from 79 to 382 individuals [8, 9, 12, 14, 15, 20, 21]. Our sensitivity rate was 78.3%, the specificity rate was 91.5%, and the overall accuracy was 93%, which is quite acceptable.

One of the most significant diagnostic challenges lies in distinguishing between adenoid cystic carcinoma (ACC) and pleomorphic adenoma [22, 23]. In our study, FNAC results for ACC were occasionally mistaken for pleomorphic adenoma due to overlapping cytological features. This diagnostic pitfall has been well-documented [12], and careful consideration of cytological characteristics, such as the presence of myxoid stroma or basaloid cells, is essential to avoid misclassification.

False negative results were another area of concern, particularly in cases of lymphoproliferative processes such as lymphoma, which can be mistaken for benign conditions like Warthin tumors [6, 8, 11, 12]. In our study, a case initially classified as benign was later found to be lymphoma upon histological examination. This underscores the importance of correlating FNAC findings with clinical and imaging data, especially when there is a suspicion of malignancy.

In cases where FNAC results are inconclusive or discordant with clinical findings, a repeat FNAC or additional diagnostic modalities may be warranted. Accurate interpretation of cytopathological results relies heavily on the experience of both the sonographer and the (cyto)pathologist, making their close collaboration crucial. It's important to correlate cytology findings with clinical symptoms and imaging results, including sonography [14–17]. However, an experienced radiologist is needed for ultrasound, and the time delay to perform ultrasound-guided aspiration may cause additional costs and even survival disadvantage. Therefore, in our study, many patients with palpable, large, and superficial masses underwent FNAC without ultrasound before surgery by skilled otolaryngologists.

Several limitations of this study should be acknowledged. First, the study's retrospective design may introduce selection bias, particularly as only patients who underwent both FNAC and surgery were included, potentially excluding those with inconclusive or unoperated cases. Second, the sample size, while comprehensive, may still limit the generalizability of our findings, especially for certain Milan categories with a smaller number of cases, such as categories IVb and V, where the risk of malignancy may vary. Third, the accuracy of FNAC heavily relies on the experience of the performing clinicians and pathologists, and variability in expertise across institutions could impact the reproducibility of our results in different clinical settings. Additionally, while our study demonstrated good diagnostic performance overall, FNAC sensitivity was lower than specificity, particularly in diagnosing low-grade malignancies such as mucoepidermoid carcinoma, which may affect clinical decision-making in borderline cases. Finally, the absence of advanced molecular or immunohistochemical techniques in our diagnostic workflow could limit the ability to refine diagnoses in challenging cases, where such methods might have improved diagnostic precision. Future studies incorporating these techniques could help address these limitations.

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5 | Conclusion

FNAC remains a pivotal preoperative diagnostic tool for parotid gland tumors, offering valuable guidance in surgical decision-making despite its limitations, such as relatively lower sensitivity and potential diagnostic discrepancies. Its high specificity and overall accuracy aid in differentiating between benign and malignant lesions, allowing for tailored surgical approaches and minimizing complications. Patients with young ages and inappropriate histories should be assessed more carefully. The Milan System's Categorization further refines our understanding of malignancy risk. The Milan System enhances diagnostic accuracy by providing a structured approach to lesion classification, thereby supporting effective management of parotid gland tumors.

Author Contributions

F.M. and B.Y.B. collected the data. All authors drafted the manuscript. All authors edited the manuscript and participated in the study design and coordination. M.O. and B.Y.B. provided the critical review and feedback. All authors read and approved the final manuscript.

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Ethics Statement

The study protocol was approved by the Ethical Committee of Non-invasive Clinical Research of Kocaeli University (Decision No: KU GOKAEK-2024/10.19, Project No: 2024/269).

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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