PREOPERATIVE DIAGNOSIS OF PAROTID TUMORS: PERFORMANCE OF ULTRASOUND, MAGNETIC RESONANCE IMAGING, AND FINE-NEEDLE ASPIRATION

DIAGNOSTIC PRÉOPÉRATOIRE DES TUMEURS DE LA PAROTIDE: EFFICACITÉ DE L'ÉCHOGRAPHIE, DE L'IMAGERIE PAR RÉSONANCE MAGNÉTIQUE ET DE LA CYTOPONCTION

I.Zoghlami, E. Sabehi, D.Chiboub, S.Bouziri , E.Rejeb, S. Arfaoui*, S.Nefzaoui, N.Romdhane, I.Hariga, Ch.Mbarek
Service d'ORL et de chirurgie cervico-faciale de l'hôpital Habib Thameur. Tunis. Tunisie.

ABSTRACT

Background: Accurate preoperative characterization of parotid gland tumors is essential for surgical planning and facial nerve preservation.
Objective: To assess the diagnostic performance of ultrasound (US), MRI, and US-guided fine-needle aspiration (FNA) in differentiating benign from malignant parotid tumors.
Methods: A retrospective study of 95 patients who underwent preoperative imaging followed by surgical resection and histopathological confirmation. Sensitivity, specificity, and predictive values were calculated for each modality.
Results: Benign tumors predominated (93.7%), mainly pleomorphic adenomas (44.2%) and Warthin tumors (31.6%). MRI showed the highest diagnostic performance, with 83.3% sensitivity and 92.1% specificity. US demonstrated 66.7% sensitivity and 80.9% specificity, while FNA showed high specificity (92.5%) but low sensitivity (33.3%). MRI and US had high negative predictive values (98.8% and 97.3%, respectively).
Conclusion: MRI provides the best preoperative assessment for suspected malignancy. US and FNA are useful initial tools, while MRI is recommended when malignancy is suspected or FNA is inconclusive. A multimodal approach improves diagnostic accuracy.
Keywords: Parotid neoplasms; Magnetic resonance imaging; Ultrasonography; Biopsy, fine-needle; Diagnostic imaging; Diagnosis, Differential

RÉSUMÉ

Introduction: La caractérisation préopératoire des tumeurs parotidiennes est essentielle à la planification chirurgicale et à la préservation du nerf facial.
Objectif: Évaluer les performances diagnostiques de l'échographie, de l'IRM et de la cytoponction à l'aiguille fine (FNA) dans la distinction entre tumeurs parotidiennes bénignes et malignes.
Méthodes: Étude rétrospective portant sur 95 patients ayant bénéficié d'une imagerie préopératoire, suivie d'une résection chirurgicale avec confirmation histologique. La sensibilité, la spécificité et les valeurs prédictives ont été ca lculées.
Résultats: Les tumeurs bénignes étaient majoritaires (93,7 %), principalement les adénomes pléomorphes (44,2 %) et les tumeurs de Warthin (31,6 %). L'IRM présentait les meilleures performances diagnostiques, avec une sensibilité de 83,3 % et une spécificité de 92,1 %. L'échographie avait une sensibilité de 66,7 % et une spécificité de 80,9 %, tandis que la FNA était très spécifique (92,5 %) mais peu sensible (33,3 %). Les valeurs prédictives négatives de l'IRM et de l'échographie étaient élevées (98,8 % et 97,3 %).
Conclusion: L'IRM est la meilleure modalité préopératoire en cas de suspicion de malignité. L'échographie et la FNA constituent des outils de première intention, tandis que l'IRM est recommandée en cas de suspicion clinique ou de FNA non concluante. Une approche multimodale optimise la précision diagnostique.
Mots-clés: Tumeurs de la parotide; Imagerie par résonance magnétique; Échographie; Cytoponction; Imagerie diagnostique; Diagnostic différentiel

Auteur correspondant: Imen Zoghlemi
E-mail: zoghlamiimen48@gmail.com

INTRODUCTION

Parotid gland tumors (PGTs) account for 3% to 6% of all head and neck neoplasms, with approximately 80% being benign. These lesions exhibit a wide histological range, with the World Health Organization identifying over 31 distinct subtypes, predominantly pleomorphic adenoma and Warthin tumor.

Accurate preoperative characterization is essential for surgical strategy and facial nerve preservation. While ultrasound (US) is a cost-effective first-line tool, its efficacy is often limited by operator dependence and poor visualization of the deep parotid lobe. Magnetic Resonance Imaging (MRI) is the “gold standard” for assessing tumor margins and perineural spread, while Fine-Needle Aspiration (FNA) offers cellular detail but exhibits variable sensitivity.

The objective of this study is to compare the diagnostic performance and specific predictive features of US, MRI, and US-guided FNA in a cohort of 95 patients to establish a refined preoperative diagnostic pathway.

MATERIALS AND METHODS

Study Design and Population: A retrospective single-center study was conducted at the ENT Department of Habib Thameur Hospital in Tunis, encompassing a cohort of 95 patients diagnosed with parotid masses.

Data Collection: Data were extracted from digitized medical records, including demographic information (age and sex) and clinical presentation (duration of evolution and physical characteristics). Preoperative diagnostic reports were collected from ultrasound and Magnetic Resonance Imaging (MRI). MRI features taken into account included: on static sequences, signal intensity on T2-weighted images, the homogeneous or heterogeneous aspect of the lesion, and tumor border definition (well-defined vs. ill-defined/infiltrative); on diffusion-weighted imaging, the relative apparent diffusion coefficient (rADC); and on dynamic contrast-enhanced sequences, the time-intensity curve (TIC) type, classified according to the Yabuuchi classification as type A, B, or C (1).

We also considered irregular morphology, ill-defined margins, heterogeneous hypoechoic echotexture, irregular hypervascularity, and regional lymphadenopathy as probable ultrasound criteria of malignancy in our study. Furthermore, results from ultrasound-guided Fine-Needle Aspiration (FNA) cytopathology and final histopathological data were integrated into the database. It is important to note as a study limitation that the Milan System for Salivary Gland Cytopathology was not used to classify the cytopathological findings of the FNAC in this cohort.

Statistical Analysis: To assess the correlation between preoperative findings and the final histopathological nature of the tumor (benign vs. malignant), the p-value was calculated using the Chi-square ($\chi 2$) test. Statistical significance was defined as a p-value < 0.05. Diagnostic accuracy metrics, including sensitivity, specificity, and predictive values (PPV/NPV), were calculated using standard contingency tables.

RESULTS

Among the 95 patients, 55% were female and 45% were male. Ages ranged from 6 to 79 years, with a mean age of 49 years. Notably, 6 patients (6.3%) had a history of previous homolateral parotid surgery, with the following initial histopathological types: 4 cases of pleomorphic adenoma, 1 case of myoepithelial carcinoma, and 1 case of Warthin tumor.

The mean duration of symptoms prior to consultation was 22 months, ranging from 1 month to 10 years. The most frequent clinical presentation was an isolated parotid swelling. Two cases (2.1%) were incidental findings. Tumor distribution showed a slight predominance on the left side (53.2%) compared to the right side (45.8%).

Physical examination revealed that the tumors were firm in 82.1% of cases, hard in 11.6%, and soft in 5.3%. A rapid growth rate, which is often considered a clinical indicator of malignancy, was observed in 5.3% of the cases.

Surgery served as the primary treatment for all 95 patients. The distribution of surgical procedures was as follows: superficial (exofacial) parotidectomy in 72.9% of cases, inferior pole parotidectomy in 10.4% of cases, and total parotidectomy in 10.4% of cases. Subtotal parotidectomy was performed in 1 patient, and neck dissection was performed in 4 patients. The definitive diagnosis was established through histopathological examination of the resected specimens. Benign lesions were identified in 93.7% of cases, while malignant tumors accounted for 6.3%. Pleomorphic Adenoma (PA) was the most frequent subtype (44.2%), followed by Warthin tumors (WT) at 31.6%. The detailed distribution of all histological types is summarized in Table I.

Table I. Distribution of Histopathological Subtypes (n=95)

Histopathological subtypes	Number of cases (n)	Percentage (%)
Benign Lesions :	89	93.7
Pleomorphic Adenoma	42	44.2
Warthin’s Tumor	30	31.6
Basal cell adenoma	6	6.3
Parotid duct cyst	3	3.2
Oncocytoma	2	2.1
Lymphoid-epithelial cyst	1	1.1
Epidermal cyst	1	1.1
Benign myoepithelioma	1	1.1
Cystic lymphangioma	1	1.1
Lipoma	1	1.1
Reactive lymph node	1	1.1
Malignant Lesions :	6	6.3
Mucoepidermoid Carcinoma	3	3.2
Carcinoma ex-pleomorphic adenoma	1	1.1
Cyst adenocarcinoma	1	1.1
Myoepithelial carcinoma	1	1.1
Total	95	100

All 95 patients (100%) underwent preoperative evaluation with both parotid ultrasound (US) and Magnetic Resonance Imaging (MRI). Ultrasound-guided Fine-Needle Aspiration (FNA) was performed in 43 cases (45.2%).

Diagnostic Accuracy of Ultrasound

Ultrasound correctly identified the lesion as intra-parotid in 90.5% of cases, while it was incorrectly staged as extra-parotid in 9.5% (Figure 1).

It provided a diagnostic orientation for the 95 cases in our cohort. The findings were distributed as follows; Benign-appearing lesions without a specific diagnostic orientation were the most common, accounting for 57.9% of cases. Features suggestive of malignancy were identified in 20% of the patients.



Figure 1: Cervical ultrasound reveals a 32-mm heterogeneous, hypoechoic, polylobulated mass arising from the inferior pole of the left parotid gland, suggestive of a pleomorphic adenoma

• Regarding specific histological suggestions, Pleomorphic Adenoma (PA) was the most frequently evoked subtype, representing 17.9% of the cases.

The overall distribution of these sonographic diagnostic orientations is illustrated in the bar chart in Figure 2.

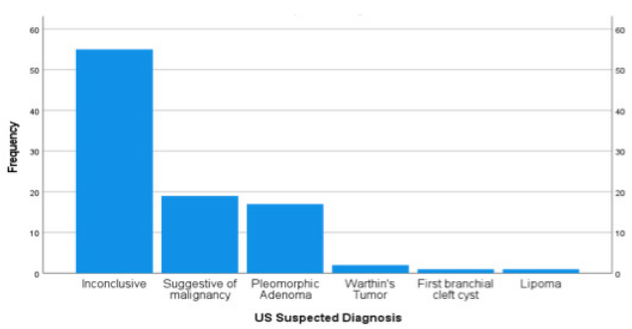


Figure 2: Distribution of Preoperative Diagnostic Orientations Based on cervical Ultrasound Findings.

The correlation between the initial ultrasound orientation and the final histopathological diagnosis revealed varying degrees of accuracy across different tumor subtypes.

• Pleomorphic Adenoma (PA): The correct histological subtype was suggested by ultrasound in 26.6% of cases. Notably, only 4.8% of these benign lesions were incorrectly classified as suspicious for malignancy.

• Warthin Tumor (WT): The diagnostic accuracy of ultrasound was lower for this subtype, with only 6.7% of cases correctly identified preoperatively. A significant proportion (36.7%) of Warthin tumors exhibited sonographic features that falsely evoked malignancy.

• Mucoepidermoid Carcinoma (MEC): Ultrasound demonstrated a higher capability in identifying malignancy for this subtype, correctly evoking malignant features in 66.7% of MEC cases.

US detected 4 of 6 malignant tumors meaning it showed a sensitivity of 66.7% and a specificity of 80.9%. While the Negative Predictive Value (NPV) remained high at 97.3%, the Positive Predictive Value (PPV) was limited to 19%.

Diagnostic Accuracy of Magnetic Resonance Imaging and Predictive Features Static Magnetic Resonance Imaging Sequences

MRI demonstrated the highest diagnostic capability in our cohort, yielding a sensitivity of 83.3%, a specificity of 92.1%, and a high Negative Predictive Value (NPV) of 98.8%. The false-negative rate was notably low at 1.2%.

Beyond overall performance, specific imaging features were analyzed for their correlation with malignancy:

T2 Signal Intensity: Hypointensity on T2-weighted images was a significant indicator of malignancy, it was observed in 50% of malignant tumors compared to only 11.2% of benign lesions. This feature was significantly correlated with a final diagnosis of malignancy ($p = 0.007$).

Tumor Border Definition: Ill-defined margins served as a robust predictor of malignancy, identified in 66.7% of malignant lesions compared to just 7.9% of benign cases. This feature was highly significantly correlated with malignancy ($p < 0.001$).

Tumor Aspect (T2 WI): While an inhomogeneous aspect on T2-weighted images was observed in 83.3% of malignant tumors, it was also present in 47.2% of benign lesions. Consequently, there was no significant correlation between inhomogeneity and malignancy in this cohort ($p = 0.087$).

The individual diagnostic metrics for these MRI features are summarized in Table II (Figure 3).

Table II. Diagnostic Performance of Specific Magnetic Resonance Imaging Features in Predicting Malignancy (n=95)

MRI feature	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P-value
T2 hypointensity	50,0	88,8	23,1	96,3	0.007
Ill-defined borders	66,7	92,1	36,4	97,6	< 0.001
T2 inhomogeneity	83,3	52,8	10,6	97,9	0.087

*PPV: Positive Predictive Value, NPV: Negative Predictive Value

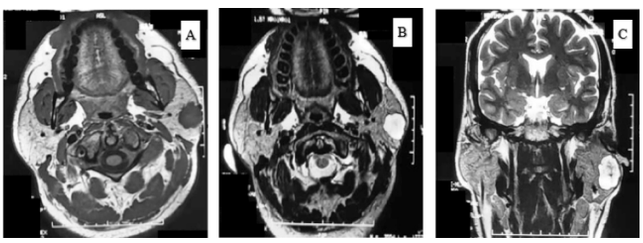


Figure 3: Parotid Magnetic Resonance Imaging: Axial T1-weighted (A), axial T2-weighted (B), and coronal T2-weighted (C) MR images demonstrate a well-defined, homogeneous lesion within the superficial lobe of the left parotid gland. The lesion appears hypointense on the T1-weighted image (A) and markedly hyperintense on the T2-weighted images (B, C), with smooth, well-circumscribed margins and no evidence of infiltration into surrounding structures. These imaging features are highly suggestive of a pleomorphic adenoma.

Diffusion-Weighted Imaging (DWI)

Apparent Diffusion Coefficient (ADC): ROC curve analysis of the rADC for the discrimination of malignant from benign parotid tumors yielded an AUC of 0.834 ($p = 0.006$). The optimal cut-off, determined by the maximum Youden index ($J = 0.663$), was an rADC of 1.10. At this threshold, rADC demonstrated a sensitivity of 100%, a specificity of 66.3%, a positive predictive value (PPV) of 16.7%, and a negative predictive value (NPV) of 100%, with an overall accuracy of 68.4%. The negative likelihood ratio was 0.00, indicating that an rADC ≥ 1.10 virtually excludes malignancy.

Dynamic Contrast-Enhanced Magnetic Resonance Imaging (DCE-MRI)

Dynamic sequences were performed in 83 of the 95 cases included. Among the 78 benign tumors, the time-intensity curve (TIC) was type A in 54 cases (69.2%), type B in 16 cases (20.5%), and type C in 8 cases (10.3%). Among the 5 malignant tumors, the TIC was type A in 3 cases (60%) and type C in 2 cases (40%); no malignant lesion showed a type B curve. TIC type distribution between benign and malignant lesions was not statistically significant in our series ($p = 0.104$) (Figure 4).

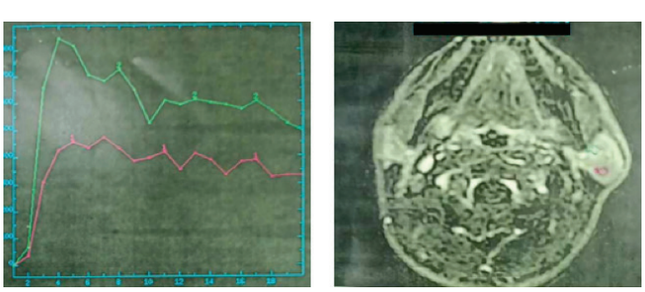


Figure 4 Dynamic contrast-enhanced Magnetic Resonance Imaging I of a lesion in the superficial lobe of the left parotid gland. The time-intensity curve shows a rapid enhancement peak followed by a washout exceeding 30%, consistent with a type B curve.

Diagnostic Accuracy of UltraSound-Guided Fine-Needle Aspiration

In the subset of 43 patients, US-guided FNA demonstrated high specificity (92.5%) but low sensitivity (33.3%) for malignancy detection, with an NPV of 94.9%. Cytological findings indicated benignity in 90.6% of cases. The predominant cytological diagnosis was non-specific benign salivary gland lesion (51.1% of FNA specimens), followed by pleomorphic adenoma (20.9%).

The comparative diagnostic performance metrics for ultrasound, MRI, and US-guided FNA in predicting malignancy within our study cohort are summarized in Table III.

Table III. Comparative Diagnostic Performance of Ultrasound, Magnetic Resonance Imaging, and UltraSound-Guided Fine-Needle Aspiration (n=95)

Diagnostic Modality	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	False-Negative Rate (%)
Ultrasound (US)	66.7	80.9	19.0	97.3	2.7
MRI	83.3	92.1	41.7	98.8	1.2
US-Guided FNA*	33.3	92.5	25.0	94.9	5.1

*Calculated for the subset of 43 patients who underwent cytological evaluation
MRI: Magnetic Resonance Imaging
US-Guided FNA: UltraSound-Guided Fine-Needle Aspiration
PPV: Positive Predictive Value
NPV: Negative Predictive Value

DISCUSSION

Histological Distribution and Prevalence

In our cohort of 95 patients, histopathological analysis, the gold standard, revealed a predominance of benign lesions (93.7%) over malignant tumors (6.3%). This prevalence of benignity is consistent with global literature, which generally reports that 75.6% to 82.8% of parotid gland tumors (PGTs) are benign (2). However, our malignancy rate (6.3%) is lower than the 10.3% to 20% often reported in larger cohorts (3). This variation may stem from the retrospective, single-center nature of our study or local referral patterns.

Consistent with the literature, our study confirmed the histological diversity of parotid gland tumors, identifying fourteen distinct histological subtypes among the 95 cases examined (4).

The prevalence of Pleomorphic Adenoma (PA) (44.2%) in our series aligns with its status as the most common parotid tumor globally, where it typically accounts for 40% to 81% of cases.

Warthin tumors (WT) followed as the second most common entity at 31.6%. This finding fits well within the standard reported range of 15% to 38.9% (5) (6).

Interestingly, recent studies report increasing Warthin tumor incidence (42-53% in certain populations), a trend partially reflected in our findings (2).

The most common malignant subtype in our cohort was mucoepidermoid carcinoma (3 of 6 cases), which

aligns with literature identifying it as the predominant malignant parotid tumor (7).

Analysis of Ultrasound (US) Predictors of Malignancy

Based on established ultrasound criteria for malignancy in the literature, we considered irregular morphology, ill-defined margins, and heterogeneous echogenicity as predictors of malignancy (8).

In our study, preoperative ultrasound (US) demonstrated a sensitivity of 66.7% and a specificity of 80.9%, confirming its role as a primary diagnostic tool for parotid gland tumors. The most significant finding regarding its performance was the Negative Predictive Value (NPV) of 97.3%, which aligns with literature suggesting that US is exceptionally reliable for ruling out malignancy in superficial lesions (2) (9).

US features of malignancy were present in 20% of cases in our cohort, with accuracy varying by subtype. For mucoepidermoid carcinoma (MEC), US correctly identified malignant features in 66.7% of cases, likely due to its characteristic infiltrative morphology with indistinct margins (10).

The “gray zone” of sonographic interpretation was evident in benign lesion misclassification. Warthin tumors posed the greatest challenge, with only 6.7% correctly identified and 36.7% falsely suggesting malignancy (11).

However, ultrasound has limitations including operator dependency, absence of standardized imaging protocols, limited specificity for histological subtyping, and difficulty assessing deep lobe or retromandibular tumors (12) (13).

These findings underscore the necessity of a multimodal diagnostic pathway. While US and US-guided FNA are effective for initial screening, MRI remains mandatory when sonographic margins are ill-defined or when the tumor is small and deeply situated (9).

Magnetic Resonance Imaging (MRI) Performance and Diagnostic Accuracy

In our cohort, MRI demonstrated the highest diagnostic capability, yielding a sensitivity of 83.3% and a specificity of 92.1%. These results reinforce the status of MRI as the “gold standard” for the preoperative evaluation of parotid gland tumors (PGTs) due to its superior soft-tissue contrast and multiplanar capabilities (14) (15). Our findings are consistent with recent literature; for instance, Kuang et al. (2025) reported an Area Under the Curve (AUC) for MRI of 0.899, which was significantly higher than that of ultrasound (0.702), indicating a much stronger overall diagnostic power (2).

A critical strength of MRI identified in our study was its Negative Predictive Value (NPV) of 98.8%, with a remarkably low false-negative rate of 1.2%. This high NPV aligns with other studies reporting values between 97% and 100%, suggesting that MRI is exceptionally reliable for ruling out malignancy (9) (16) (17). This diagnostic certainty allows surgeons to confidently plan conservative, nerve-sparing procedures such as superficial parotidectomy for benign-appearing lesions (18).

Analysis of MRI Predictive Features

Our analysis of specific MRI parameters confirms that certain morphological and signal characteristics are robust predictors of malignancy:

- Tumor Border Definition: In our series, ill-defined or infiltrative margins were found in 66.7% of malignant tumors compared to only 7.9% of benign cases, a correlation that was highly significant ($p < 0.001$). This is strongly supported by the sources, which identify ill-defined margins as the single best discriminator for malignancy ($p < 0.001$) (17) (19) (20).
- T2 Signal Intensity: We observed that T2 hypointensity was present in 50% of malignant tumors but only 11.2% of benign lesions ($p = 0.007$). This finding is consistent with the literature linking low T2 signal intensity to high tumor cellularity in malignant neoplasms (20) (21) (22) . Conversely, a high signal intensity on T2-weighted images is a well-known indicator of the fibromyxoid stroma characteristic of pleomorphic adenomas (20,23)
- Inhomogeneity and Enhancement: While inhomogeneity on T2-weighted images was common in our malignant cases (83.3%), it lacked statistical significance ($p = 0.087$) because it was also highly prevalent in benign lesions (47.2%), particularly in Warthin tumors with protein-rich cystic components. These findings are consistent with previously described MRI characteristics of Warthin tumors, which emphasize their inherent heterogeneous imaging appearance. (20) (24).
- Apparent diffusion coefficient: In the present study, diffusion-weighted imaging (DWI) with relative apparent diffusion coefficient (rADC) measurement demonstrated significant diagnostic value for the preoperative characterization of parotid gland tumors, with an area under the ROC curve (AUC) of 0.834 ($p = 0.006$). Our rADC cut-off of 1.10falls within this reported range and is consistent with values proposed in the literature. Celebi et al. reported an ADC cut-off of 1.165×10^{-3} mm²/s optimizing sensitivity and specificity at 63.3% and 71.9%, respectively, for distinguishing parotid malignancy (25).

The principal strength of rADC in our cohort lies in its rule-out value. NPV reached 100%, meaning that no malignant tumor in our series exhibited an rADC ≥ 1.10. However, the specificity of rADC in our series was moderate (66.3%), and the positive predictive value (PPV) was low at 16.7%. These findings are primarily attributable to the presence of Warthin tumors, which constituted the majority of false-positive cases (rADC < 1.10 in the absence of malignancy).

- Dynamic Contrast-Enhanced MRI (DCE-MRI) In our series, the majority of benign tumors showed a type A curve (69.2%), which is consistent with the literature, where this progressive enhancement pattern is

classically reported as the most common among benign lesions, particularly pleomorphic adenoma (1). In these foundational studies, TIC type was significantly correlated with tumor histologic type, an association also confirmed by subsequent studies, notably Elmokadem et al. (2019), who reported a highly significant difference in TIC type distribution between benign and malignant lesions ($p < .001$) (26).In contrast, our series did not find a statistically significant association between perfusion curve type and the benign or malignant nature of the tumor ($p = 0.104$). This discrepancy is likely related to the small number of malignant tumors that underwent dynamic sequence acquisition in our cohort ($n = 5$), which considerably limited the statistical power of the analysis and made it difficult to demonstrate a true difference, despite an overall qualitative trend consistent with the literature: no type B curve among malignant tumors, and type C curves observed almost exclusively in malignant lesions.

MRI showed superior diagnostic over ultrasound in our cohort (sensitivity 83.3%, specificity 92.1%), consistent with literature reporting higher Area Under the Curve (AUC) for MRI (0.899 vs. 0.702) (2). Notably, both modalities exhibited high Negative Predictive Values (98.8% for MRI; 97.3% for US), making them reliable for ruling out malignancy. Our data support combining US and MRI to maximize preoperative precision.

In our cohort, MRI demonstrated the highest diagnostic capability, yielding a sensitivity of 83.3% and a specificity of 92.1%. These results reinforce the status of MRI as the “gold standard” for the preoperative evaluation of parotid gland tumors (PGTs) due to its superior soft-tissue contrast and multiplanar capabilities (14,15). Our findings are consistent with recent literature. Kuang et al. (2025), in a retrospective series of 214 patients, demonstrated that MRI was significantly superior to ultrasound in the diagnostic evaluation of parotid gland tumors ($p < 0.001$) with the combined US-MRI approach achieving the highest specificity (94.8%) compared with either modality alone (2). Similarly, in an older but frequently cited series comparing the three main cross-sectional imaging modalities in 121 patients, a diagnostic accuracy of 94.4% for MRI versus only 77.7% for ultrasound was reported, confirming that ultrasound was significantly less accurate than both MRI and CT (27).

However, this superiority is not consistently reported across all series. Stoia et al. (2025), in a prospective cohort of 35 patients, found equivalent diagnostic performance between ultrasound and MRI (sensitivity 80%, specificity 97%, accuracy 94% for both modalities), suggesting that the two techniques may perform comparably for superficial, well-accessible lesions (9). Likewise, an extended case study found broadly similar accuracy across ultrasound, CT, and MRI, while emphasizing that ultrasound specifically failed to visualize deep-lobe tumors, all of which were correctly assessed on MRI (28). This apparent discrepancy across studies likely reflects differences in tumor location, sonographer experience, and sample size, all of which are known to influence the comparative performance of US relative to MRI.

The Role and Limitations of Fine-Needle Aspiration (FNA)

In our cohort, US-guided FNA showed high specificity (92.5%) and NPV (94.9%), confirming its reliability as a confirmatory test for benignity These results align with literature reporting specificity of 86-100% (29).

However, the major limitation identified in our study was a low sensitivity of 33.3% for predicting malignancy. While some series report higher sensitivity (up to 80-96%) , others acknowledge a “gray zone” where sensitivity can drop significantly depending on the pathologist’s experience and tumor characteristics (29).

CONCLUSION

Preoperative parotid tumor characterization is essential for surgical planning and nerve preservation. MRI demonstrated superior accuracy (sensitivity 83.3%, specificity 92.1%), with ill-defined margins and T2 hypointensity predicting malignancy ($p < 0.01$). Despite high NPV for US (97.3%) and specificity for FNA, neither alone is sufficient. We recommend US and FNA for superficial lesions, with MRI mandatory for suspected malignancy, inconclusive FNA, or deep lobe lesions.

Declarations

• Acknowledgements: Not applicable.
• Funding: This research received no external funding.
• Conflicts of Interest: The authors declare no conflicts of interest.
• Ethics approval and consent to participate: The present study was approved by the ethics committee of Habib Thameur Hospital. The data is anonymous and the requirement for informed consent was therefore waived.
• Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES:

1. Yabuuchi H, Fukuya T, Tajima T, Hachitanda Y, Tomita K, Koga M. Salivary gland tumors: diagnostic value of gadolinium-enhanced dynamic MR imaging with histopathologic correlation. Radiology. 2003 Feb;226(2):345–54. doi:10.1148/radiol.2262011486 PubMed PMID: 12563124.
2. Kuang J, Rao Q, Cheng Z. Diagnostic accuracy of ultrasound and MRI in parotid gland tumors: A retrospective study. Experimental and Therapeutic Medicine. 2025 Sep 1;30(3):1–11. doi:10.3892/etm.2025.12920
3. Sungur N, Akan İM, Ulusoy MG, Özdemir R, Kilinç H, Ortak T. Clinicopathological Evaluation of Parotid Gland Tumors: A Retrospective Study. Journal of Craniofacial Surgery. 2002 Jan;13(1):26.
4. Sarradin V, Siegfried A, Uro-Coste E, Delord JP. [WHO classification of head and neck tumours 2017: Main novelties and update of diagnostic methods]. Bull Cancer. 2018 Jun;105(6):596–602. doi:10.1016/j.bulcan.2018.04.004 PubMed PMID: 29759330.
5. Gontarz M, Bargiel J, Gąsiorowski K, Marecik T, Szczurowski P, Zapała J, et al. Epidemiology of Primary Epithelial Salivary Gland Tumors in Southern Poland-A 26-Year, Clinicopathologic, Retrospective Analysis. J Clin Med. 2021 Apr 13;10(8):1663. doi:10.3390/jcm10081663 PubMed PMID: 33924553; PubMed Central PMCID: PMC8070067.
6. Bradley PJ, McGurk M. Incidence of salivary gland neoplasms in a defined UK population. British Journal of Oral and Maxillofacial Surgery. 2013 Jul 1;51(5):399–403. doi:10.1016/j.bjoms.2012.10.002
7. Inaka Y, Kawata R, Haginomori S ichi, Terada T, Higashino M, Omura S, et al. Symptoms and signs of parotid tumors and their value for diagnosis and prognosis: a 20-year review at a single institution. Int J Clin Oncol. 2021 Jul 1;26(7):1170–8. doi:10.1007/s10147-021-01901-3
8. Gritzmann N, Rettenbacher T, Hollerweger A, Macheiner P, Hübner E. Sonography of the salivary glands. Eur Radiol. 2003 May 1;13(5):964–75. doi:10.1007/s00330-002-1586-9
9. Stoia S, Ciurea A, Băciuț M, Bran S, Armencea G, Boțan E, et al. Comparative Diagnostic Accuracy of Ultrasound, MRI, and Fine-Needle Aspiration Biopsy in the Preoperative Evaluation of Parotid Gland Tumors. Journal of Clinical Medicine. 2025 Jan;14(4):1342. doi:10.3390/jcm14041342
10. Shuting L. Mucoepidermoid Carcinoma of Parotid Gland: 2 Cases and Literature Review. Vol. 8. 8(6).
11. Liu W, Zhang F, Pang K, Bao Y, Zhang L, Wei X. A Comparative Study of Pleomorphic Adenoma and Warthin Tumor Using Ultrasonography and Clinical Features. Ultrasound Quarterly. 2025 Dec;41(4):e00723. doi:10.1097/RUQ.0000000000000723
12. Cantisani V, David E, Sidhu PS, Sacconi B, Greco A, Pandolfi F, et al. Parotid Gland Lesions: Multiparametric Ultrasound and MRI Features. Ultraschall in der Medizin - European Journal of Ultrasound. 2016 Jun 14;37:454–71. doi:10.1055/s-0042-109171
13. Cortcu S, Elmali M, Tanrivermis Sayit A, Terzi Y. The Role of Real-Time Sonoelastography in the Differentiation of Benign From Malignant Parotid Gland Tumors. Ultrasound Quarterly. 2018 Jun;34(2):52. doi:10.1097/RUQ.0000000000000323
14. Lee YYP, Wong KT, King AD, Ahuja AT. Imaging of salivary gland tumours. European Journal of Radiology. 2008 Jun 1;66(3):419–36. doi:10.1016/j.ejrad.2008.01.027 PubMed PMID: 18337041.
15. Liu Y, Zheng J, Zhao J, Yu L, Lu X, Zhu Z, et al. Magnetic resonance image biomarkers improve differentiation of benign and malignant parotid tumors through diagnostic model analysis. Oral Radiol. 2021 Oct 1;37(4):658–68. doi:10.1007/s11282-020-00504-4
16. Stoia S, Băciuț G, Lenghel M, Badea R, Csutak C, Rusu GM, et al. Cross-sectional imaging and cytologic investigations in the preoperative diagnosis of parotid gland tumors – An updated literature review. Bosn J Basic Med Sci. 2021 Feb;21(1):19–32. doi:10.17305/bjbms.2020.5028 PubMed PMID: 32893758; PubMed Central PMCID: PMC7861630.
17. Coudert H, Mirafzal S, Dissard A, Boyer L, Montoriol PF. Multiparametric magnetic resonance imaging of parotid tumors: A systematic review. Diagnostic and Interventional Imaging. 2021 Mar 1;102(3):121–30. doi:10.1016/j.diii.2020.08.002
18. Maahs GS, Oppermann P de O, Maahs LGP, Machado Filho G, Ronchi AD. Parotid gland tumors: a retrospective study of 154 patients. Braz J Otorhinolaryngol. 2015;81(3):301–6. doi:10.1016/j.bjorl.2015.03.007 PubMed PMID: 25934418; PubMed Central PMCID: PMC9452231.
19. Tartaglione T, Botto A, Sciandra M, Gaudino S, Danieli L, Parrilla C, et al. Differential diagnosis of parotid gland tumours: which magnetic resonance findings should be taken in account? Acta Otorhinolaryngol Ital. 2015 Oct;35(5):314–20. doi:10.14639/0392-100X-693 PubMed PMID: 26824912; PubMed Central PMCID: PMC4720931.
20. Christe A, Waldherr C, Hallett R, Zbaeren P, Thoeny H. MR Imaging of Parotid Tumors: Typical Lesion Characteristics in MR Imaging Improve Discrimination between Benign and Malignant Disease. American Journal of Neuroradiology. 2011 Aug 1;32(7):1202–7. doi:10.3174/ajnr.A2520 PubMed PMID: 21724574.
21. Takashima S, Sone S, Takayama F, Maruyama Y, Hasegawa M, Horii A, et al. Assessment of parotid masses: which MR pulse sequences are optimal? European Journal of Radiology. 1997 May 1;24(3):206–15. doi:10.1016/S0720-048X(96)01132-1
22. Joe VQ, Westesson PL. Tumors of the parotid gland: MR imaging characteristics of various histologic types. American Journal of Roentgenology. 1994 Aug;163(2):433–8. doi:10.2214/ajr.163.2.8037045
23. Okahara M, Kiyosue H, Hori Y, Matsumoto A, Mori H, Yokoyama S. Parotid tumors: MR imaging with pathological correlation. Eur Radiol. 2003 Dec;13 Suppl 4:L25-33. doi:10.1007/s00330-003-1999-0 PubMed PMID: 15018162.
24. Vogl TJ, Dresel SH, Späth M, Grevers G, Wilimzig C, Schedel HK, et al. Parotid gland: plain and gadolinium-enhanced MR imaging. Radiology. 1990 Dec;177(3):667–74. doi:10.1148/radiology.177.3.2243966 PubMed PMID: 2243966.
25. Celebi I, Mahmutoglu AS, Ucgul A, Ulusay SM, Basak T, Basak M. Quantitative diffusion-weighted magnetic resonance imaging in the evaluation of parotid gland masses: a study with histopathological correlation. Clin Imaging. 2013;37(2):232–8. doi:10.1016/j.clinimag.2012.04.025 PubMed PMID: 23465973.
26. Elmokadem AH, Abdel Khalek AM, Abdel Wahab RM, Tharwat N, Gaballa GM, Elata MA, et al. Diagnostic Accuracy of Multiparametric Magnetic Resonance Imaging for Differentiation Between Parotid Neoplasms. Can Assoc Radiol J. 2019 Aug;70(3):264–72. doi:10.1016/j.carj.2018.10.010 PubMed PMID: 30922790.
27. Grazioli L, Olivetti L, Stanga C, Matricardi L, Fugazzola C, Bergamo Andreis IA, et al. Comparison of ultrasound, CT and MRI in the assessment of parotid masses. Eur Radiol. 1994 Dec 1;4(6):549–56. doi:10.1007/BF00226828
28. Rudack C, Jörg S, Kloska S, Stoll W, Thiede O. Neither MRI, CT nor US is superior to diagnose tumors in the salivary glands – an extended case study. Head Face Med. 2007 Apr 3;3:19. doi:10.1186/1746-160X-3-19 PubMed PMID: 17407595; PubMed Central PMCID: PMC1852309.
29. Guiban O, Rubini A, Fresilli D, Lucarelli GT, Ralli M, Cassoni A, et al. Preoperative Multiparametric Ultrasound and Fine Needle Aspiration Cytology evaluation of parotid gland tumors: which is the best technique? Medical Ultrasonography. 2021 Nov 25;23(4):402–9. doi:10.11152/mu-3068