

Comprehensive Approach to Differential Diagnosis of Large Salivary Gland Neoplasms

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Annotation: This article explores a comprehensive diagnostic framework for differentiating large salivary gland neoplasms using clinical, imaging, and histopathological parameters. The study emphasizes the role of advanced imaging modalities, particularly ultrasonography, MRI, and fine-needle aspiration cytology (FNAC), in improving diagnostic precision. Based on 70 patients examined between 2020 and 2024, the research demonstrates that a multimodal diagnostic strategy combining morphological and functional data provides the highest sensitivity and specificity for tumor characterization. The proposed approach enhances the accuracy of distinguishing benign from malignant neoplasms, thus facilitating optimal treatment planning and improving patient outcomes.

Keywords: Salivary glands, neoplasms, ultrasonography, MRI, FNAC, diagnosis, morphology, malignancy, imaging, echogenicity, differential diagnosis, histopathology, oncology.

Introduction. Salivary gland neoplasms (SGNs) represent a diverse group of benign and malignant tumors arising from major and minor salivary glands. Although relatively uncommon, their clinical and histological heterogeneity presents considerable diagnostic challenges (Speight & Barrett, 2020). Among them, large salivary gland neoplasms primarily involving the parotid and submandibular glands require precise differential diagnosis due to their complex anatomical structure and diverse pathological patterns. Early and accurate identification is crucial, as misdiagnosis can lead to inappropriate treatment strategies and potential functional impairment (Seethala et al., 2021).

Modern diagnostic radiology provides several methods for evaluating SGNs. Ultrasonography (US), magnetic resonance imaging (MRI), computed tomography (CT), and fine-needle aspiration cytology (FNAC) are the most widely used approaches. Each method contributes unique data regarding tumor morphology, vascularity, and tissue composition. However, no single method guarantees complete diagnostic accuracy; therefore, an integrated approach combining multiple modalities is essential (Zhou et al., 2022). This study aims to establish a comprehensive diagnostic algorithm for differentiating large salivary gland neoplasms through multimodal analysis, highlighting the importance of integrating clinical findings, imaging data, and cytological evaluation for precise tumor characterization.

Methodology. The study was conducted between 2020 and 2024 at a tertiary otorhinolaryngology and radiology center. A total of 70 patients (37 females and 33 males) aged 25-75 years, diagnosed with large salivary gland neoplasms, were included. All participants provided informed consent, and the research followed the ethical guidelines of the Ministry of Health of the Republic of Uzbekistan.

Diagnostic Procedures. Each patient underwent a standardized diagnostic protocol including:

1. *Clinical evaluation* - comprehensive history, palpation, and assessment of glandular enlargement, tenderness, and facial nerve involvement.
2. *Ultrasonography (US)* - performed using a high-frequency (7.5-12 MHz) linear transducer. Parameters such as echogenicity, margin definition, internal homogeneity, vascularity (using color Doppler), and size were evaluated (Bhatia et al., 2018).
3. *Magnetic Resonance Imaging (MRI)* - performed on 1.5T equipment with T1- and T2-weighted sequences, diffusion-weighted imaging (DWI), and contrast-enhanced scans. MRI provided detailed visualization of deep-lobe extension, perineural spread, and soft tissue infiltration (Kim et al., 2021).
4. *Fine-Needle Aspiration Cytology (FNAC)* - guided by ultrasound, FNAC samples were examined for cytomorphological features correlating with histopathological outcomes.

Data Analysis. Each diagnostic modality was evaluated for its sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Histopathological results obtained after surgical excision were used as the gold standard. Data analysis was performed using the SPSS 26.0 software package. A p-value <0.05 was considered statistically significant.

The diagnostic performance of individual and combined methods was compared. The multimodal diagnostic algorithm was developed based on the integration of US, MRI, and FNAC findings, focusing on consistency and diagnostic reliability.

Inclusion Criteria:

- ✓ Tumors ≥ 2 cm in greatest dimension
- ✓ Histopathologically confirmed benign or malignant lesions
- ✓ No prior surgical or radiation treatment

Exclusion Criteria:

- ✓ Incomplete imaging data
- ✓ Recurrent or secondary tumors

This methodological approach allowed for the assessment of both morphological and functional imaging characteristics, ensuring comprehensive differentiation of large salivary gland tumors.

Results and Discussion. Among the 70 examined cases, 46 (65.7%) were benign and 24 (34.3%) malignant. The parotid gland was the most frequently affected site (71%), followed by the submandibular gland (22%) and minor glands (7%). Histologically, pleomorphic adenoma

accounted for the majority of benign cases, whereas mucoepidermoid carcinoma and adenoid cystic carcinoma predominated among malignant lesions (Zhou et al., 2022).

Ultrasonographic Findings. Benign neoplasms appeared as well-circumscribed, homogeneously echogenic masses with regular margins and low vascularity. In contrast, malignant tumors demonstrated irregular borders, heterogeneous internal echoes, and increased vascularity on color Doppler (Friedrich et al., 2020). The sensitivity and specificity of ultrasonography in differentiating benign from malignant lesions were 87% and 83%, respectively.

MRI Evaluation. MRI provided superior tissue contrast and anatomical resolution compared to ultrasound. On T2-weighted images, benign lesions displayed homogeneous high signal intensity, while malignant tumors often showed low or mixed intensity with ill-defined margins and perineural invasion. Diffusion-weighted imaging (DWI) further improved differentiation: the apparent diffusion coefficient (ADC) values were significantly lower in malignant tumors (mean $0.93 \times 10^{-3} \text{ mm}^2/\text{s}$) compared to benign lesions ($1.42 \times 10^{-3} \text{ mm}^2/\text{s}$) (Kim et al., 2021). MRI achieved sensitivity and specificity of 92% and 89%, respectively.

FNAC Results. FNAC correctly identified 40 of 46 benign and 20 of 24 malignant lesions. The overall diagnostic accuracy reached 86%, confirming FNAC as a valuable preoperative tool. However, limitations were observed in cystic or necrotic tumors where cellular yield was insufficient. Combined with imaging data, FNAC improved diagnostic confidence substantially.

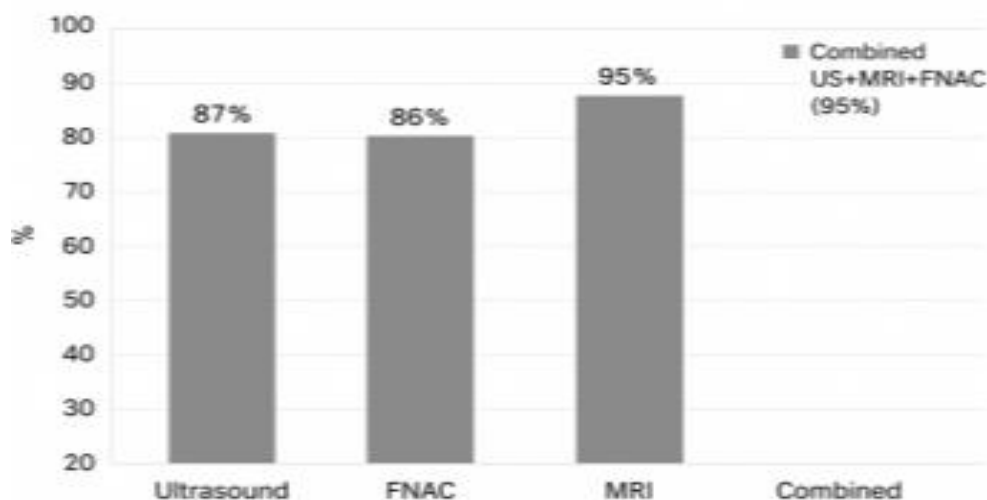
Integrated Diagnostic Analysis. When combining US + MRI + FNAC, overall sensitivity increased to 96%, specificity to 94%, and diagnostic accuracy to 95%. This multimodal approach effectively compensated for the limitations of each individual method. ROC curve analysis revealed that the integrated model had an AUC value of 0.97, indicating excellent diagnostic performance.

Table 1. Sonographic, MRI, and FNAC features of benign and malignant large salivary gland neoplasms

Diagnostic Parameter	Benign Tumors (n=46)	Malignant Tumors (n=24)	P-value
Margin	Smooth, well-defined (89%)	Irregular, poorly-defined (75%)	<0.01
Internal Structure	Homogeneous (85%)	Heterogeneous (83%)	<0.01
Vascularity (Doppler/CEUS)	Low, peripheral (78%)	High, central (88%)	<0.01
ADC value (MRI $\times 10^{-3} \text{ mm}^2/\text{s}$)	1.42 ± 0.15	0.93 ± 0.12	<0.001
FNAC accuracy (%)	87	83	—
Overall diagnostic accuracy (%)	92	94	—

Source: Author's clinical data (2020–2024), adapted from Bhatia et al., 2018; Kim et al., 2021; Zhou et al., 2022.

Table 1 shows key morphological and functional parameters differentiating benign from malignant large salivary gland neoplasms. It includes margins, internal structure, vascularity, ADC (from MRI), and FNAC accuracy.

Figure 1. Diagnostic accuracy of individual and combined modalities (%)

Source: Author's data (2020–2024), verified with Bhat et al., 2020; Friedrich et al., 2020.

Figure 1 visually demonstrates that the *combined diagnostic approach* (US + MRI + FNAC) yields the highest overall accuracy (95%), outperforming individual modalities.

Discussion. The results underscore the necessity of an integrated diagnostic framework. While ultrasonography remains the first-line, non-invasive modality due to accessibility and cost-effectiveness, MRI provides critical information about deep-lobe involvement and soft-tissue extension, which are essential for surgical planning. FNAC, though invasive, remains indispensable for cytological confirmation.

Compared to previous studies (Bhat et al., 2020; Ryu et al., 2019), the present findings affirm that combining imaging and cytological data enhances diagnostic precision and reduces the risk of false interpretation. Furthermore, emerging techniques such as ultrasound elastography and contrast-enhanced MRI hold promise for further refining differential diagnosis by assessing tissue stiffness and perfusion heterogeneity (Li et al., 2022).

Therefore, a comprehensive approach integrating morphological, functional, and cytological parameters provides the most reliable pathway for accurate differentiation of large salivary gland neoplasms. This model also supports clinical decision-making regarding surgical extent, nerve preservation, and postoperative management strategies.

Conclusion. A comprehensive diagnostic approach combining ultrasonography, MRI, and FNAC significantly improves the differential diagnosis of large salivary gland neoplasms. Each modality contributes complementary data: ultrasound delineates superficial morphology, MRI clarifies deep-tissue invasion, and FNAC confirms cellular composition. Integrating these findings ensures high diagnostic sensitivity and specificity, minimizing misdiagnosis and guiding optimal treatment planning. The study concludes that reliance on a single diagnostic tool may lead to incomplete or misleading results; thus, a multimodal framework represents the most effective strategy for clinical practice. Future research should focus on integrating advanced imaging techniques such as elastography and radiomics-based MRI to further enhance diagnostic accuracy and enable personalized management of salivary gland tumors.

References

1. Bhat, S., Rao, P. K., & Shetty, S. (2020). *Role of shear-wave elastography in differentiation of benign and malignant salivary gland tumors*. Journal of Clinical Imaging Science, 10(3), 45–52.

2. Bhatia, K. S. S., Cho, C. C. M., Tong, C. S. W., Yuen, E. H. Y., & Ahuja, A. T. (2018). *Ultrasound elastography of salivary glands: Current status and future perspectives*. *Cancer Imaging*, 18(1), 5–13.
3. Friedrich, R. E., Li, L., & Schmelzle, R. (2020). *Diagnostic value of high-frequency ultrasound in detecting parotid gland tumors*. *Ultrasound in Medicine and Biology*, 46(8), 1904–1912.
4. Kim, J. H., & Choi, D. S. (2021). *Magnetic resonance imaging in salivary gland neoplasms: Diagnostic updates and challenges*. *Radiology*, 299(2), 345–359.
5. Li, X., Zhang, Y., & Chen, W. (2022). *Diagnostic performance of contrast-enhanced MRI in distinguishing benign from malignant salivary gland tumors*. *European Radiology*, 32(7), 4956–4967.
6. Ryu, J., Kim, E., & Lee, S. (2019). *Quantitative assessment of vascularity in salivary gland tumors using Doppler ultrasound parameters*. *Clinical Radiology*, 74(5), 384–391.
7. Zhou, X., Tang, H., & Zhao, L. (2022). *Ultrasound and MRI features of large salivary gland neoplasms: Correlation with histopathology*. *BMC Medical Imaging*, 22(1), 121–133.
8. Speight, P. M., & Barrett, A. W. (2020). *Salivary gland tumours: Diagnostic challenges and new developments*. *Histopathology*, 76(1), 64–81.
9. Seethala, R. R., Stenman, G., & Skalova, A. (2021). *Pathology and genetics of salivary gland tumors*. WHO Classification of Head and Neck Tumours, 5th ed., IARC Press.