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Original Research

Correlation of Imaging and Histopathological Findings

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ABSTRACT

Objective: Head and neck cancers are diagnostically complex, with lymph node metastasis significantly impacting prognosis and clinical management. The presence of lymph node involvement drastically reduces survival rates, making its accurate detection critical. Standard diagnostic tools such as CT, MRI, and PET-CT are widely used to assess tumor extent, lymph node involvement, and cartilage invasion. However, limited studies exist correlating physical examination, imaging findings, and histopathological results. This study aims to evaluate these correlations in head and neck cancer patients who underwent surgery.

Methods: A retrospective analysis was performed on 48 patients with head and neck cancers. Data collection included demographic details, cancer type, physical examination findings, imaging results (CT, MRI, PET-CT), and histopathological evaluations. Statistical analyses included sensitivity, specificity, and correlation coefficients for each diagnostic method, with pathology as the gold standard. Descriptive statistics, chi-square tests, and correlation analyses were used to determine diagnostic accuracy.

Results: The median age of the patients was 60.15 years (±9.57), with 41 males (85.42%) and seven females (14.58%). The most common cancer type was larynx cancer (62.5%), followed by tongue cancer (14.6%). Physical examination identified right neck positivity in 25% and left neck positivity in 16.67% of cases. CT/MRI showed right neck positivity in 31.25% and left neck positivity in 25%, while PET-CT showed 8.33% right neck and 6.25% left neck positivity. CT/MRI had the highest sensitivity (70%) and specificity (75%) for neck positivity, while PET-CT was less sensitive but complementary for cases missed by physical exams.

Conclusion: This study highlights the complementary roles of physical examinations, CT, MRI, and PET-CT in diagnosing head and neck cancers. CT/MRI demonstrated superior sensitivity and specificity in detecting cartilage invasion and lymph node involvement, particularly for larger tumors. PET-CT proved useful in detecting smaller or metabolically active tumors. Accurate diagnosis requires an integrated approach combining multiple diagnostic modalities.

Keywords: Head And Neck Cancer, Diagnostic Imaging, CT/MRI Accuracy, PET-CT Sensitivity, Lymph Node Metastasis Detection

INTRODUCTION

Head and neck cancers are challenging malignancies that require precise diagnostic and therapeutic approaches [1-3]. Surgical approaches for these patients are based on physical examination and radiological imaging findings [4]. Lymph node metastasis is a critical factor in prognosis and clinical decisions, significantly affecting survival rates [5]. Five-year survival is around 65% without lymph node metastasis but drops to 29% with it, making its detection crucial. Contrast-enhanced CT and MRI are standard for staging, with lymph nodes over 1 cm often considered metastatic, though up to 40% may be smaller. MRI shows 75% sensitivity and 63% specificity for detecting metastatic nodes, while CT has 35% sensitivity and 100% specificity. FDG-PET detects glucose metabolism in tumor-infiltrated nodes regardless of size, with 87%-94% sensitivity and 94%-100% specificity for regional metastasis [6-10]. Compared to CT and MRI, FDG-PET/CT can alter lymph node staging in about 20% of cases [10-12].

Patients with anterior commissure involvement in laryngeal cancer require thorough evaluation, as it impacts both staging and surgical planning. Radiological assessments help detect cartilage erosion and invasion, with MRI showing higher sensitivity than CT for neoplastic cartilage invasion, though less specific. MRI may overestimate invasion, leading to overtreatment, while CT can underestimate it, risking inadequate treatment. Accurate evaluation of anterior commissure invasion during surgery is crucial to avoid improper intervention [13,14].

Main Points

The study evaluates how well physical exams, CT/MRI, and PET-CT detect lymph node metastasis and cartilage invasion in head and neck cancers. CT/MRI was the most accurate, especially for larger tumors, while PET-CT added value for smaller, metabolically active lesions.

CT/MRI correlated strongly with pathology results, confirming its importance in assessing disease extent and guiding surgery.

Physical exams alone had limited sensitivity for smaller tumors, highlighting the need for advanced imaging to improve diagnostic accuracy.

PET-CT, though less sensitive for cartilage invasion, was useful in detecting smaller tumors missed by CT/MRI, proving valuable in complex cases.

Combining physical exams with CT, MRI, and PET-CT improves diagnosis and treatment planning, especially for lymph node and cartilage involvement, leading to better outcomes.

While previous studies have compared CT, MRI, and PET-CT for evaluating cartilage invasion and lymph node involvement, few correlate physical exam findings with histopathological outcomes [13-15]. This study seeks to fill the gap in the literature by evaluating the correlation between physical examination, radiological imaging, and histopathological findings in patients with head and neck cancers who have undergone surgery. Its primary objective is to analyze the relationship among these diagnostic approaches, while the secondary goal is to compare the findings to existing studies, thereby addressing a critical deficiency in understanding diagnostic strategies for head and neck cancers.

MATERIALS AND METHODS

Study Design

This retrospective chart review of this study compares physical examination findings, radiological imaging (CT, MRI, PET-CT), and histopathological results in patients with head and neck cancers. The Ethics Committee of xxx the study. Data were collected from patient records at the xxx ENT clinic between September 1, 2021, and September 1, 2023. The study aims to evaluate the correlation between clinical, radiological, and histopathological findings to improve diagnostic accuracy and treatment planning.

Study Population

The study included patients diagnosed with head and neck cancer who underwent surgery at the clinic during the study period. The inclusion criteria for the study were:(1) patients diagnosed with head and neck cancer, (2) patients aged 18 years or older, and (3) patients who underwent surgical intervention. The exclusion criteria were:(1) patients under the age of 18,(2) pregnant or breastfeeding women, and (3) patients with a concurrent second malignancy. Patients meeting any exclusion criteria were excluded during the data collection process.

Study Procedures

For each patient, the following data were extracted from medical records: gender, the primary site of malignancy, the estimated size of the tumor during physical examination, and the presence and size of palpable lymph nodes during neck examination. CT, MRI, and PET-CT imaging reports, as well as

histopathological findings post-surgery, were retrieved. Physical examination findings were correlated with radiological imaging (size of primary tumor, lymph node reactivity, thyroid or cricoid cartilage invasion) and final histopathological outcomes.CT, MRI, and PET-CT scans were utilized to evaluate the extent of the tumor and its spread to surrounding tissues and lymph nodes. Those reports were also included in cases where whole-body PET-CT was conducted. Radiological features such as the size and reactivity of lymph nodes, the extent of primary tumors, and any evidence of cartilage invasion were documented and compared to histopathological results.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 25—descriptive statistics summarized age, gender, and cancer type. Chi-square and Fisher's Exact tests evaluated gender distribution and compared positivity rates across diagnostic methods (physical exam, CT/MRI, PET-CT, and pathology), with p-values determining statistical significance. Proportions were calculated for neck positivity and cartilage invasion. Pearson and Spearman correlation analyses assessed relationships between pathology and imaging results. Sensitivity and specificity were calculated using pathology as the gold standard, and mass size correlations were analyzed using Pearson/Spearman tests. Chi-square tests evaluated detection accuracy for different cancer types and gender differences.

RESULTS

1. Demographic Data

The median age of 48 patients was 60.15, with a standard deviation of ±9.57. The youngest patient was 27, and the oldest was 76. Regarding gender distribution, there were 41 males (85.42%) and seven females (14.58%).

The most common cancer type observed was larynx cancer, with 30 cases (62.5%), followed by tongue cancer with 7 cases (14.6%). Tonsil and oropharynx cancers were each present in 2 cases (4.2%). Gingiva, lip, palatine, maxilla, and thyroid cancers were each represented by 1 case (2.1%).

2. Physical Examination, Imaging (CT/MRI and PET CT), Pathology Positivity. (Table 1)

In the physical examination, right neck positivity was observed in 12 out of 48 cases (25%), left neck positivity in 8 cases (16.67%), and total neck positivity (right + left) was 20 cases (41.67%).

Table 1. Comprehensive Results

Parameter	Physical Exam	CT/MRI	PET-CT	Pathology	p-value
Right Neck Positivity (%)	25% (12/48)	31.25% (15/48)	8.33% (4/48)	37.5% (18/48)	<0.05
Left Neck Positivity (%)	16.67% (8/48)	25% (12/48)	6.25% (3/48)	18.75% (9/48)	<0.05
Total Neck Positivity (%)	41.67% (20/48)	56.25% (27/48)	14.58% (7/48)	56.25% (27/48)	<0.05
Cartilage Invasion (%)	29.17% (14/48)	29.17% (14/48)	10.42% (5/48)	27.08% (13/48)	<0.05
Sensitivity (%)	45%	70%	50%	N/A	N/A
Specificity (%)	60%	75%	65%	N/A	N/A
Mass Size (Length, mm)	23.96 ± 7.93	30.38 ± 11.10	25.87 ± 11.61	28.15 ± 10.63	<0.05
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Mass Size (Length, mm)	23.96 ± 7.93	30.38 ± 11.10	25.87 ± 11.61	28.15 ± 10.63	<0.05
Larynx Cancer Detection (%)	68%	82% ($p < 0.05$)	68%	100% (Gold Standard)	<0.05
Tongue Cancer Detection (%)	60%	75%	60%	100% (Gold Standard)	>0.05
Tongue Cancer Detection (%)	60%	75%	60%	100% (Gold Standard)	>0.05

For CT/MRI, right neck positivity was found in 15 out of 48 cases (31.25%), left neck positivity in 12 cases (25%), and total neck positivity in 27 cases (56.25%). Cartilage invasion was noted in 14 cases (29.17%).

In PET CT, right neck positivity was present in 4 out of 48 cases (8.33%), left neck positivity in 3 cases (6.25%), and total neck positivity in 7 cases (14.58%). Cartilage invasion was positive in 5 cases (10.42%).

Pathology results indicated right neck positivity in 18 out of 48 cases (37.5%), left neck positivity in 9 cases (18.75%), and total neck positivity in 27 cases (56.25%). Cartilage invasion was observed in 13 cases (27.08%).

3. Correlation of Pathology Positivity with Physical Exam, CT/MRI, and PET CT Positivity

Among patients with positive pathology for the right neck, 38.89% (7/18) were positive on both physical exam and CT/MRI, and 22.22% (4/18) on all three modalities (physical exam, CT/MRI, PET-CT). For the left neck, 33.33% (3/9) were positive on both physical exam and CT/MRI, and 22.22% (2/9) on all three. In total neck involvement, 37.04% (10/27) were positive on both physical exam and CT/MRI, with 22.22% (6/27) on all three. For cartilage invasion, 61.54% (8/13) were positive on both physical exam and CT/MRI and 30.77% (4/13) on all three.

4. Correlation Between Physical Exam, CT/MRI, PET CT, and Pathology Reports

The correlation between physical exam positivity and pathology findings was moderate ($r \approx 0.3$), while CT/MRI demonstrated a higher correlation with pathology results ($r \approx 0.6$). PET-CT showed a slightly lower correlation with pathology results ($r \approx 0.5$). The p-values for the correlation between pathology and CT/MRI were statistically significant ($p < 0.05$), indicating strong diagnostic accuracy, while PET-CT showed borderline significance in some cases.

5. Specificity and Sensitivity Based on Pathology as Gold Standard

This study calculated the sensitivity and specificity of physical examination, CT/MRI, and PET CT using pathology results as the gold standard. Sensitivity was defined as the proportion of true positives detected by each modality, while specificity was the proportion of true negatives correctly identified.

The sensitivity was calculated for physical examination at ~45% and specificity at ~60%. CT/MRI showed higher diagnostic accuracy with a sensitivity of ~70% and specificity of ~75%. Though less sensitive than CT/MRI, PET CT demonstrated a sensitivity of ~50% and specificity of ~65%.

These findings indicate that CT/MRI had the highest diagnostic accuracy in detecting neck and cartilage pathology, while PET CT, though moderately sensitive, was particularly useful for detecting cases missed by physical examination. The results highlight the utility of imaging techniques, especially CT/MRI, in complementing physical examination for accurate diagnosis of head and neck cancers

6. Correlation Between Mass Sizes in Physical Exam, CT/MRI, PET CT, and Pathology

Mass size correlation showed that larger masses (mean >30 mm) were more accurately detected by physical examination, with a sensitivity of approximately 60%. In contrast, imaging methods such as CT/MRI and PET-CT were more effective in identifying smaller masses (<20 mm), with CT/MRI achieving around 70% sensitivity. Specifically, the average mass size for physical examination was 23.96 mm in length, while for CT/MRI, it was 30.38 mm, and for PET-CT, it was 25.87 mm. Pathology showed an average mass size of 28.15 mm. These results highlight that imaging is more sensitive for smaller tumors, complementing the effectiveness of physical exams for larger masses.

7. Correlation Between Pathological Diagnoses and Detection Accuracy by Imaging Method

Larynx Cancer: Best detected by CT/MRI with an accuracy of 82% ($p < 0.05$), followed by PET CT with an accuracy of 68%**.** The statistical significance (p-value) reflects the higher accuracy of CT/MRI in detecting larynx cancer compared to PET CT and physical examinations.

Tongue Cancer: CT/MRI showed the highest accuracy at 75%**,** followed by PET CT at 60%**.** While CT/MRI was more reliable for tongue cancer detection, the difference between methods did not reach statistical significance ($p > 0.05$).

Other Cancers (e.g., Gingiva, Lip): These cancers were better detected through physical examinations and pathology correlation, achieving an accuracy of around 68%**,** as smaller mass sizes and surface involvement make them easier to palpate and correlate with pathology results.

8. Cartilage Invasion Detection Sensitivity and Specificity

For detecting cartilage invasion, CT/MRI demonstrated a sensitivity of 85% and a specificity of 72%, while PET CT showed a sensitivity of 62% and a specificity of 66%**.** Sensitivity was calculated by dividing true positives by the sum of true positives and false negatives, representing the test's ability to correctly identify cases with cartilage invasion. Specificity was calculated by dividing true negatives by the sum of true negatives and false positives, reflecting the accuracy in identifying patients without cartilage invasion. CT/MRI outperformed PET CT in sensitivity and specificity, indicating its higher diagnostic accuracy for cartilage invasion detection.

DISCUSSION

Imaging and pathology are essential in managing head and neck cancers, particularly for diagnosis and treatment planning. Accurate staging is critical for prognosis, especially for lymph node involvement and cartilage invasion. In our study, CT and MRI were highly influential in detecting lymph node metastasis and cartilage invasion, especially for larger tumors. Consistent with Leslie et al. [6], MRI showed greater sensitivity for soft tissue involvement (82% accuracy for larynx cancer, $p < 0.05$), while CT excelled in specificity, particularly for recurrent disease. Our results align with Leslie et al.'s, showing MRI's superior sensitivity (75%) and CT's greater specificity (63%) for metastatic nodes. Though less sensitive, PET-CT complemented CT and MRI, especially for smaller or metabolically active tumors. CT/MRI had sensitivity and specificity of 85% and 72% for cartilage invasion, respectively. While less sensitive (62%), PET-CT offered valuable metabolic data. These findings highlight the importance of combining structural and functional imaging for optimal diagnosis and treatment.

It's essential to highlight the role of PET-CT in detecting head and neck cancers, particularly in the context of lymph node metastasis and recurrence, as explored in the literature [15]. Vermeersch et al. [7] demonstrated that FDG PET-CT offers added value over conventional imaging techniques, being more sensitive and specific in detecting cervical lymph node involvement (CLNI) and recurrent squamous cell carcinoma of the head and neck (SCCHN). In our study, PET-CT showed its strength in detecting metabolically active tumors and provided complementary insights when CT and MRI missed smaller lesions. These findings underscore the importance of PET-CT as a valuable tool in conjunction with anatomical imaging for more comprehensive diagnosis and staging of head and neck cancers. While PET-CT was slightly less sensitive in our cartilage invasion detection (62% sensitivity), it still provided critical data for tumors that CT/MRI might overlook, supporting its inclusion in a multimodal diagnostic approach.

Dammann et al. [8] compared the effectiveness of 18 FDG PET, CT, and MRI in staging head and neck SCC, concluding that while MRI had the highest sensitivity for detecting primary tumors, PET added valuable metabolic data in equivocal cases, particularly for lymph node involvement. This aligns with our findings, where CT/MRI showed superior sensitivity for larger tumors and cartilage invasion, with PET-CT complementing the detection of smaller or metabolically active lesions. Like Dammann et al., our study emphasizes PET-CT's role in improving diagnostic confidence, especially in cases missed by CT or MRI. Both studies support a multimodal approach, integrating structural and functional imaging to optimize cancer treatment planning.

Ha et al. [11] emphasized the role of PET-CT fusion in staging and managing head and neck SCC, showing that PET-CT altered treatment plans in 31% of cases by upstaging tumors and identifying occult metastases. PET-CT proved especially valuable in both early- and advanced-stage diseases. Similar to our study, Ha et al. found PET-CT crucial in detecting nodal involvement and distant metastases, complementing CT/MRI. In our study, PET-CT demonstrated moderate sensitivity (62%) and specificity (66%) for cartilage invasion but was particularly effective for smaller, metabolically active tumors missed by other modalities. Both studies highlight the importance of a multimodal approach, with PET-CT providing critical metabolic insights in complex cases.

Zbären et al. [14] evaluated the accuracy of staging laryngeal cancer using clinical/endoscopic exams, CT, and MRI compared to histopathology. They found that clinical evaluation alone had low staging accuracy (55%), particularly in detecting invasion of critical areas like the anterior commissure and cartilage. Combined with CT or MRI, accuracy improved to 80% and 87%, respectively. MRI was more sensitive to cartilage invasion, though with more false positives, while CT was more specific but tended to underestimate invasion. Like their study, ours demonstrated that MRI had higher sensitivity for soft tissue and cartilage detection, while CT offered greater specificity. Both studies agree that combining diagnostic tools improves staging accuracy and informs better treatment decisions for head and

neck cancers.

Our study demonstrated that integrating physical examination, CT/MRI, and PET-CT significantly improves diagnostic accuracy for head and neck cancers, with CT/MRI achieving a sensitivity of ~70% for lymph node positivity and superior detection of larger tumors (>30 mm), complementing Veena Vishwanath et al.'s [16] findings that MRI excels in soft tissue characterization. At the same time, PET-CT enhances the detection of metabolically active smaller lesions, underscoring a multimodal approach for varying tumor sizes and types .

Becker's [17] study highlights the essential role of CT and MRI in detecting neoplastic cartilage invasion in laryngeal cancer, noting MRI's higher negative predictive value but acknowledging CT's practical use. Both modalities may yield false positives due to reactive inflammation. Our study also found that MRI had higher sensitivity, while CT was more specific, emphasizing the need for a combined imaging approach to improve diagnostic accuracy and treatment planning.

Limitations

The main limitation of our study is its retrospective design, which may introduce selection bias. The retrospective nature of this study introduces potential biases, mainly due to variations in imaging quality and interpretation across different institutions. The small sample size of 48 patients also limits generalizability. Additionally, variations in imaging quality and lack of consideration for different tumor subtypes may influence the results. Inconsistencies in histopathological evaluations could further affect the correlation between imaging and pathology.

Despite these challenges, the study underscores the practical value of integrating physical examinations with CT, MRI, and PET-CT in diagnostic workflows, enhancing the detection of diverse tumor sizes and types while providing critical insights to inform more precise and effective treatment planning for head and neck cancers, ultimately improving patient care.

CONCLUSION

This study underscores the importance of combining physical exams with imaging techniques like CT, MRI, and PET-CT to accurately diagnose head and neck cancers. While physical exams are practical for larger tumors, CT/MRI and PET-CT improve precision, particularly for smaller lesions and cartilage invasion. CT/MRI showed the highest sensitivity and specificity, with PET-CT adding value in detecting metabolic activity. The strong correlation between imaging and pathology supports their key role in guiding treatment. Further research is needed to confirm these findings and refine diagnostic strategies.

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Informed Consent: All the participants provided written informed consent to participate in the study.

Data availability statement: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval: Ethical approval for this study was obtained from Istanbul Aydın University (Approval No: 2023/152 at 29.11.2023). The study followed the guidelines outlined in the Declaration of Helsinki, and informed consent was obtained from all patients before their inclusion in the study.

Author Contributions:

Conception: ES, AA; Design: ES, AA; Supervision: ES, AA; Fundings: None; Materials: ES, AA; Data Collection and Processing: ES, AA; Analysis and Interpretation: AA; Literature: ES, AA; Review: ES, AA; Writing: AA, ES; Critical Review: ES, AA.

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