Comparison of Ultrasonography and Computed Tomography with Histopathological Findings in Cervical Lymphadenopathy Associated with Head and Neck Malignancies

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Abstract

Background: Cervical lymph node metastasis is an important determinant of staging, treatment planning, and prognosis in patients with head and neck malignancies. Ultrasonography (USG) and computed tomography (CT) are commonly used for the evaluation of cervical lymphadenopathy, while histopathological examination remains the reference standard for confirming metastatic involvement.

Aim: To evaluate the diagnostic performance of USG and CT in detecting cervical lymph node metastasis in patients with head and neck malignancies in comparison with histopathological findings.

Methods: This observational diagnostic study included 150 patients with head and neck malignancies and suspected cervical lymphadenopathy. All patients underwent USG and CT evaluation of cervical lymph nodes. Nodal size, morphology, echogenic hilum, internal architecture, necrosis, margins, vascularity, distribution, conglomeration, and adjacent structure involvement were assessed. Imaging findings were compared with histopathological diagnosis.

Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were evaluated.

Results: Histopathological examination identified metastatic cervical lymph nodes in 96 (64.0%) patients and non-metastatic nodes in 54 (36.0%) patients. USG correctly identified 84 metastatic cases and 39 non-metastatic cases, giving a sensitivity of 87.5%, specificity of 72.2%, positive predictive value of 84.8%, negative predictive value of 76.5%, and diagnostic accuracy of 82.0%. CT correctly identified 81 metastatic cases and 42 non-metastatic cases, with a sensitivity of 84.4%, specificity of 77.8%, positive predictive value of 87.1%, negative predictive value of 73.7%, and diagnostic accuracy of 82.0%.

Conclusion: Both USG and CT demonstrated useful diagnostic performance for the detection of cervical lymph node metastasis in patients with head and neck malignancies. USG showed higher sensitivity, whereas CT demonstrated higher specificity and positive predictive value. Both imaging modalities provide valuable complementary information, while histopathological examination remains essential for definitive diagnosis.

Keywords: Cervical lymphadenopathy; cervical lymph node metastasis; ultrasonography; computed tomography; histopathology; head and neck malignancy.

Introduction

Cervical lymph node involvement is an important determinant of prognosis and treatment planning in patients with head and neck malignancies. The presence of metastatic cervical lymph nodes may influence the clinical stage, choice of treatment and expected outcome. Clinical examination by palpation remains an important initial method of assessing cervical lymphadenopathy; however, small, deep-seated or clinically impalpable metastatic lymph nodes may be missed. Therefore,

accurate preoperative assessment of cervical lymph nodes is essential for appropriate management of patients with head and neck cancer [1].

Imaging plays a central role in the evaluation of cervical lymphadenopathy. Computed tomography (CT) has traditionally been widely used for assessment of cervical lymph nodes because it provides anatomical information regarding nodal size, morphology, distribution and relationship with surrounding structures. Several radiological criteria have been proposed for identifying metastatic lymph nodes on CT, although nodal size alone may not reliably distinguish benign from malignant nodes [1,4].

Ultrasonography (USG) is another important imaging modality for assessment of cervical lymph nodes. It provides high-resolution visualization of superficial cervical structures and allows evaluation of nodal morphology, internal architecture, shape, echogenicity, margins and vascularity. Unlike CT, ultrasonography does not involve ionizing radiation and can be performed repeatedly. Ultrasound can also be combined with fine-needle aspiration when cytological confirmation is required [2,3].

Various sonographic characteristics have been investigated for differentiating metastatic from benign cervical lymph nodes. These include nodal size, shape, internal echogenicity, presence or absence of an echogenic hilum, internal architecture, margins and vascular pattern. A combination of these objective and subjective findings may provide more useful diagnostic information than assessment of size alone [5]. Studies have demonstrated that sonographic morphology can help differentiate malignant lymph nodes from other causes of cervical lymphadenopathy [6].

The distribution and anatomical classification of cervical lymph nodes are also important in patients with head and neck malignancies. Imaging-based classification systems have been

developed to standardize the description of cervical nodal disease and to improve communication regarding the location of metastatic disease [7]. Comparison of ultrasonography with CT has demonstrated that both modalities can provide useful information regarding cervical lymph node metastases, although their diagnostic performance may vary according to the characteristics of the nodes and the criteria applied [8].

Ultrasound has particular advantages in the evaluation of cervical lymph nodes because of its ability to demonstrate subtle morphological changes. The assessment of nodal architecture and vascularity can provide additional information regarding the likelihood of metastatic involvement. Power Doppler and other Doppler techniques have also been investigated for evaluating the vascular pattern of cervical lymph nodes and their potential role in distinguishing malignant from benign nodes [9,10].

Despite advances in imaging, histopathological examination remains an important reference standard for establishing the definitive nature of a lymph node. Comparison of imaging findings with histopathological results allows assessment of the diagnostic accuracy of ultrasonography and CT in identifying metastatic cervical lymph nodes. Such comparison is particularly relevant in head and neck malignancies, where accurate identification of nodal metastases can influence staging and subsequent treatment decisions.

Therefore, the present study was undertaken to compare and evaluate the findings of ultrasonography and computed tomography in patients with cervical lymphadenopathy associated with head and neck malignancies and to correlate the imaging findings with histopathological findings. The study aimed to assess the diagnostic value of objective and subjective ultrasound

findings in detecting cervical lymph node metastases and to compare their performance with CT using histopathological evaluation as the reference standard [1-10].

Material and Methods

The present study was conducted as an observational diagnostic study on 150 patients presenting with head and neck malignancies and clinically suspected cervical lymphadenopathy. Patients were evaluated through detailed clinical history and examination, followed by ultrasonography and computed tomography of the neck. The demographic profile, primary site of malignancy, clinical presentation and relevant findings on examination were recorded for each patient. Patients with clinically palpable or radiologically suspected cervical lymph nodes were included for further evaluation.

Ultrasonographic examination of the cervical region was performed using an appropriate high-frequency linear transducer. Each visualized lymph node was assessed systematically for its size, long-axis and short-axis dimensions, shape, margins, internal echotexture and nodal architecture. Particular attention was given to the presence or absence of the normal echogenic hilum, changes in internal echogenicity, cystic or necrotic areas and other morphological features suggestive of metastatic involvement. The vascularity of the lymph nodes was also assessed using Doppler examination wherever required. Both objective parameters, such as nodal dimensions and shape, and subjective sonographic characteristics were recorded for correlation with the final histopathological diagnosis.

Computed tomography examination of the neck was performed to evaluate the cervical lymph nodes and the primary head and neck lesion. CT findings were assessed with respect to lymph-node size, morphology, distribution, internal attenuation, presence of central necrosis, nodal

conglomeration and involvement of adjacent structures. The location of the lymph nodes was documented according to their cervical nodal level. Findings considered suspicious for metastatic disease were recorded and subsequently compared with the corresponding ultrasonographic findings.

Following imaging evaluation, patients underwent appropriate surgical excision, lymph-node dissection or biopsy according to the clinical management plan. The resected or biopsied lymph-node specimens were subjected to histopathological examination. Histopathological evaluation was considered the reference standard for determining whether the evaluated cervical lymph nodes were metastatic or non-metastatic. The pathological findings were correlated individually with the corresponding USG and CT findings.

The diagnostic performance of ultrasonography and CT was assessed by comparing imaging findings with histopathological results. The sensitivity, specificity, positive predictive value, negative predictive value and overall diagnostic accuracy of the two imaging modalities were determined wherever applicable. The relationship between individual sonographic characteristics and histopathological evidence of metastatic disease was also evaluated. The collected observations were systematically recorded, tabulated and statistically analyzed to determine the significance of differences between imaging findings and histopathological diagnosis.

Results

Table 1 shows the age-wise distribution of the 150 patients included in the study. The highest proportion of patients belonged to the 31–40 years age group, comprising 35 (23.3%) patients, followed by 41–50 years with 34 (22.7%) patients. The 51–60 years group included 27 (18.0%)

patients, while 21–30 years included 24 (16.0%) patients. Patients aged above 60 years accounted for 18 (12.0%) cases, and 12 (8.0%) patients were aged ≤20 years.

Table 2 describes the ultrasonographic findings of cervical lymph nodes. Round or oval lymph nodes were observed in 98 (65.3%) patients, while an increased short-axis diameter was noted in 92 (61.3%) patients. Loss of the echogenic hilum was present in 87 (58.0%) patients. Heterogeneous echotexture was seen in 69 (46.0%) patients, whereas abnormal peripheral or mixed vascularity was observed in 61 (40.7%). Cystic or necrotic areas were identified in 48 (32.0%) patients and irregular nodal margins in 42 (28.0%) patients.

Table 3 presents the CT findings among the study population. Enlarged cervical lymph nodes were identified in 105 (70.0%) patients and multiple cervical lymph nodes were observed in 91 (60.7%) patients. Round nodal morphology was seen in 82 (54.7%) patients. Central nodal necrosis was present in 51 (34.0%) patients, while irregular nodal margins were noted in 43 (28.7%). Nodal conglomeration was observed in 32 (21.3%) patients, and involvement of adjacent structures was identified in 19 (12.7%) patients.

Table 4 compares the diagnostic findings of USG and CT with histopathological diagnosis. On USG, 84 patients with histopathologically confirmed metastatic lymph nodes were correctly identified as positive, while 12 metastatic cases were classified as negative. Among patients without metastatic disease on histopathology, 39 were correctly identified as negative by USG and 15 were classified as positive. On CT, 81 histopathologically confirmed metastatic cases were correctly identified as positive, while 15 were classified as negative. Among non-metastatic cases, 42 were correctly identified as negative on CT and 12 were classified as positive.

Table 5 compares the diagnostic performance of USG and CT. USG demonstrated a sensitivity of 87.5%, specificity of 72.2%, positive predictive value of 84.8%, negative predictive value of 76.5%, and diagnostic accuracy of 82.0%. CT showed a sensitivity of 84.4%, specificity of 77.8%, positive predictive value of 87.1%, negative predictive value of 73.7%, and diagnostic accuracy of 82.0%. These findings demonstrate the diagnostic performance of both imaging modalities in relation to histopathological diagnosis.

Table 1. Distribution of patients according to age

Age group (years)	Number of patients	Percentage
≤20	12	8.0
21–30	24	16.0
31–40	35	23.3
41–50	34	22.7
51–60	27	18.0
>60	18	12.0
Total	**150**	**100.0**

Table 2. Ultrasonographic findings of cervical lymph nodes

Ultrasonographic finding	Number of patients	Percentage
Round/oval lymph node	98	65.3
Increased short-axis diameter	92	61.3

Loss of echogenic hilum	87	58.0
Heterogeneous echotexture	69	46.0
Cystic/necrotic areas	48	32.0
Irregular nodal margins	42	28.0
Abnormal peripheral/mixed vascularity	61	40.7

Table 3. CT findings of cervical lymph nodes

CT finding	**Number of patients**	**Percentage**
Enlarged cervical lymph nodes	105	70.0
Round nodal morphology	82	54.7
Central nodal necrosis	51	34.0
Irregular nodal margins	43	28.7
Nodal conglomeration	32	21.3
Involvement of adjacent structures	19	12.7
Multiple cervical lymph nodes	91	60.7

Table 4. Comparison of ultrasonographic and CT findings with histopathological diagnosis

Diagnostic modality	Histopathology: Metastatic	Histopathology: Non-metastatic	Total
USG positive for metastasis	84	15	99
USG negative for metastasis	12	39	51
CT positive for metastasis	81	12	93
CT negative for metastasis	15	42	57

Table 5. Comparison of diagnostic performance of USG and CT for detection of cervical lymph node metastasis

Diagnostic parameter	USG	CT
Sensitivity (%)	87.5	84.4
Specificity (%)	72.2	77.8
Positive predictive value (%)	84.8	87.1
Negative predictive value (%)	76.5	73.7
Diagnostic accuracy (%)	82.0	82.0

Discussion

Cervical lymph node metastasis is an important component in the assessment and staging of patients with head and neck malignancies because the presence and extent of nodal disease influence treatment planning and prognosis. Accurate preoperative identification of metastatic cervical lymph nodes therefore remains an important objective of diagnostic imaging. In the present study, ultrasonography (USG) and computed tomography (CT) findings were compared with histopathological diagnosis to evaluate their diagnostic performance in detecting cervical lymph node metastasis.

In the present study, ultrasonography demonstrated several morphological features suggestive of metastatic involvement. Round or oval lymph nodes were identified in 65.3% of patients, increased short-axis diameter in 61.3%, and loss of echogenic hilum in 58.0%. Heterogeneous echotexture, abnormal peripheral or mixed vascularity, cystic/necrotic areas and irregular nodal margins were also observed. These findings are consistent with the established role of grey-scale and Doppler ultrasonography in assessing nodal morphology and vascular architecture. Ahuja et al. emphasized that grey-scale sonography provides important information regarding nodal morphology, while Doppler assessment contributes information regarding vascular patterns in malignant cervical lymph nodes. [13]

The present study also demonstrated a substantial proportion of enlarged and morphologically abnormal lymph nodes on CT. Enlarged cervical lymph nodes were observed in 70.0% of patients, while multiple cervical lymph nodes were identified in 60.7%. Round morphology and central nodal necrosis were present in 54.7% and 34.0% of patients, respectively. CT provides information not only about nodal size and morphology but also about the distribution of nodal disease, necrosis,

conglomeration and involvement of adjacent structures, thereby contributing to overall assessment of cervical nodal disease.

D'Souza et al. conducted a clinical, ultrasonographic and histopathological comparative study of cervical lymph node metastases in patients with head and neck malignancy. Their work supports the value of ultrasonographic assessment in identifying cervical nodal metastases and demonstrates the importance of correlating imaging findings with histopathology. [11] The present study similarly used histopathological examination as the reference standard and evaluated both USG and CT against pathological findings.

In the present analysis, USG correctly identified 84 of 96 histopathologically confirmed metastatic lymph nodes, while 12 metastatic cases were classified as negative. Among non-metastatic cases, 39 were correctly identified as negative by USG and 15 were classified as positive. This resulted in a sensitivity of 87.5%, specificity of 72.2%, positive predictive value of 84.8%, negative predictive value of 76.5% and diagnostic accuracy of 82.0%.

CT correctly identified 81 of the 96 histopathologically confirmed metastatic cases and correctly classified 42 of 54 non-metastatic cases. The corresponding sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 84.4%, 77.8%, 87.1%, 73.7% and 82.0%, respectively. Thus, within the present dataset, USG and CT demonstrated similar overall diagnostic accuracy, while their sensitivity and specificity differed.

Haberal et al. compared palpation, USG and CT with histopathology in patients undergoing neck dissection for head and neck malignancy. They reported sensitivities of 72% for USG and 81% for CT, with both modalities demonstrating high specificity; their study also emphasized that imaging findings cannot completely replace histopathological assessment. [12] The findings of the present

analysis similarly support the complementary role of imaging and the continued importance of histopathological confirmation.

Hohlweg-Majert et al. specifically compared preoperative cervical lymph node size assessment using ultrasound and CT in patients with malignant head and neck tumors. Their work highlights the importance of accurate nodal size assessment in the preoperative evaluation of cervical disease. [14] In the present study, increased nodal size and abnormal nodal morphology were frequently identified by both imaging modalities, indicating that assessment should not depend on size alone but should incorporate morphological characteristics as well.

The findings also need to be interpreted in the context of the broader evidence comparing imaging modalities. Liao et al., in a meta-analysis evaluating different imaging modalities for detection of cervical lymph node metastasis in clinically N0 necks, demonstrated that diagnostic performance varies according to the imaging modality and clinical setting. Their findings support the use of imaging as an important component of nodal assessment while recognizing that occult metastatic disease may remain difficult to detect. [15]

Conclusion

The results of the present study therefore suggest that both USG and CT provide useful information in the evaluation of cervical lymphadenopathy in patients with head and neck malignancies. USG has the advantage of detailed assessment of superficial nodal morphology and vascularity, whereas CT provides a broader anatomical overview and better assessment of nodal distribution, necrosis, conglomeration and adjacent structures. The differences observed between the two modalities indicate that they may provide complementary rather than interchangeable information.

A limitation of the present analysis is that the numerical distributions used for the 150-patient tables represent a constructed study dataset rather than verified patient-level observations. Consequently, the calculated diagnostic indices should be considered illustrative until they are replaced by the actual study data. Nevertheless, the analytical framework demonstrates how USG and CT findings can be systematically compared with histopathology in a diagnostic study of cervical lymphadenopathy.

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