Sonographic Evaluation of Cervical Lymph Nodes

Ultrasonography is a noninvasive, accessible, and highly sensitive imaging modality for the evaluation of cervical lymph nodes. By combining gray-scale and color Doppler techniques, ultrasonography provides detailed information on nodal morphology, internal architecture, and vascular patterns, thereby aiding in the differentiation between benign and malignant conditions.

Normal or reactive lymph nodes typically appear oval or elongated with smooth and well-defined margins. They contain a central echogenic hilum representing fatty and vascular structures, and their cortex is thin and uniform. The echogenicity of the node is generally homogeneous and hypoechoic relative to adjacent muscles. On Doppler imaging, blood flow is usually detected within the central hilar region and demonstrates a low-resistance pattern (resistive index [RI] < 0.8). These findings are commonly observed in submandibular, parotid, upper deep cervical, and posterior triangle areas, often representing reactive changes secondary to infection or inflammation.

In contrast, malignant lymph nodes tend to show structural distortion and a more rounded configuration, with a short-to-long axis ratio greater than 0.5. The echogenic hilum is frequently absent, and the node may exhibit eccentric cortical thickening, irregular or poorly defined margins, and infiltration into adjacent soft tissues. The internal echotexture is heterogeneous, often reflecting necrosis, fibrosis, or tumor infiltration. Central cystic necrosis and microcalcifications are important diagnostic signs—particularly in metastases from papillary thyroid carcinoma, which may appear markedly hyperechoic with fine punctate calcifications. On Doppler evaluation, malignant nodes commonly demonstrate peripheral or mixed vascularity with increased vessel density and a higher resistive index (RI > 0.8), reflecting disruption of the normal vascular architecture.

Lymphomatous nodes usually present as round, markedly hypoechoic structures with smooth margins but absence of the echogenic hilum. They often show a fine internal reticular pattern, sometimes described as intranodal reticulation. Vascularity tends to be diffuse or mixed, and flow may remain low in resistance. Clinically, lymphomatous involvement is often multifocal, symmetric, and involves multiple regional nodal groups.

Tuberculous lymphadenitis frequently manifests as round or oval hypoechoic lymph nodes with absent hilum and central cystic necrosis due to caseation. Nodes may cluster and

adhere together, producing a characteristic matted appearance, and perinodal soft-tissue edema is frequently observed. On Doppler imaging, the normal hilar vascularity may be displaced or absent due to necrosis, and peripheral flow patterns are sometimes noted. These appearances can overlap with metastatic disease or suppurative infection, highlighting the need for clinical correlation and histopathologic confirmation.

Atypical or inflammatory conditions such as Kikuchi-Fujimoto disease, Kimura's disease, and Rosai-Dorfman disease can also cause cervical lymphadenopathy with varying sonographic appearances. Kikuchi and Kimura diseases usually show lymph nodes resembling reactive hyperplasia, maintaining an oval shape and a preserved echogenic hilum. In contrast, Rosai-Dorfman disease may produce markedly hypoechoic and heterogeneous nodes that can mimic malignant involvement; internal echogenic foci may represent histiocytic proliferation. In such cases, tissue biopsy is often indispensable for diagnosis.

Several sonographic criteria are helpful for differential diagnosis, including the shape ratio (short-to-long axis), presence or absence of the echogenic hilum, cortical thickness and uniformity, presence of intranodal necrosis or calcification, perinodal soft-tissue changes, and distribution of vascular flow. Emerging techniques such as elastography can provide additional diagnostic value by assessing tissue stiffness—malignant nodes typically exhibit greater rigidity than reactive ones. Furthermore, contrast-enhanced ultrasonography offers real-time visualization of blood flow characteristics, highlighting peripheral or heterogeneous enhancement patterns suggestive of malignancy or necrosis.

In conclusion, ultrasonography is an invaluable first-line imaging tool for the assessment of cervical lymph nodes. When morphological and Doppler features are analyzed together, diagnostic accuracy significantly improves. Key ultrasonographic signs suggesting abnormal or malignant lymph nodes include round shape, loss of the echogenic hilum, irregular margins, necrosis, calcification, matting, perinodal edema, and peripheral vascularity. Integrating these imaging findings with clinical context and, when necessary, histopathologic data remains essential for accurate diagnosis and appropriate management.