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Carotid Ultrasonography: Clinical Applications, Diagnostic Criteria, and Risk Stratification

Carotid ultrasonography remains the primary imaging modality for assessing carotid artery stenosis in both symptomatic and asymptomatic cohorts. It plays a pivotal role in acute stroke diagnostics, longitudinal risk stratification, and the formulation of definitive treatment strategies.

Clinical Indications for Carotid Imaging
Prompt carotid evaluation is mandatory for all patients presenting with cerebral ischemic symptoms, including transient ischemic attack or acute ischemic stroke. Classic carotid-territory manifestations include contralateral motor or sensory deficits of the face or extremities, as well as ipsilateral amaurosis fugax. Furthermore, imaging is indicated for patients with retinal artery embolization identified via fundoscopy or those with evidence of "silent" cerebral infarction on neuroimaging.
While universal screening for the asymptomatic general population is not recommended due to low prevalence, targeted screening is warranted for high-risk individuals. Specifically, patients aged 55 or older with multiple cardiovascular comorbidities—such as hypertension, coronary artery disease, smoking history, or a family history of stroke—should be considered. Notably, the prevalence of significant stenosis correlates strongly with the number of risk factors, reaching up to 67% in patients possessing four or more clinical markers.

Diagnostic Performance and Standardized Criteria
Carotid ultrasonography offers high diagnostic accuracy, with a sensitivity of 85–92% and a specificity of 84% for detecting high-grade (70–99%) internal carotid artery stenosis. According to established consensus criteria, a peak systolic velocity of ≥125 cm/s is the benchmark for identifying stenosis of 50% or greater. In well-selected cases, the unequivocal identification of 50–99% stenosis in symptomatic patients, or 70–99% in asymptomatic patients, provides sufficient evidence to proceed with clinical intervention.

Stroke Risk Stratification and Plaque Morphology
The risk of ipsilateral stroke is fundamentally linked to the severity of the narrowing.
Asymptomatic Patients: The 5-year stroke risk is relatively low (<5%) for moderate stenosis (50–69%) but escalates to approximately 15% for severe stenosis (70–99%). Patients with 80–99% stenosis face an 18.3% 5-year risk, compared to just 1.0% in those with 50–79% stenosis.
Beyond luminal diameter, plaque morphology serves as a vital prognostic indicator. High-risk features—such as plaque heterogeneity, intraplaque hemorrhage, ulceration, and echolucency—markedly increase the incidence of stroke across all grades of stenosis, particularly when coupled with severe narrowing.

Limitations and Multimodal Imaging
Despite its utility, carotid ultrasonography has limitations, particularly in the presence of extensive arterial calcification which may obscure the acoustic window. In such equivocal cases, cross-sectional imaging via CTA or MRA is indicated. CTA is often preferred for heavily calcified vessels, while MRA or CTA is essential

when the clinical context requires evaluation of the vasculature proximal or distal to the cervical segment for surgical or interventional planning.

Longitudinal Surveillance
For patients with documented stenosis >50%, annual surveillance via carotid ultrasonography is a prudent approach to monitor for disease progression. Key predictors for the acceleration of stenosis include male sex, elevated serum creatinine, the absence of statin therapy, and an increasing total plaque area.