PHILIPS

Ultrasound

Case study

Diagnosis of radiation arteritis of the carotid artery

Duplex ultrasound with Live xPlane and 3D imaging

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Medical history

A 73-year-old man has a relevant medical history of coronary artery disease, status post coronary artery bypass grafting, peripheral arterial disease, hypertension, hyperlipidemia and 30-pack per year tobacco use. He quit tobacco use at the time of his cardiac surgery. Approximately five years later, he was experiencing pain and burning while eating certain foods. Examination revealed an ulcerated mass on the right side of his tongue. He underwent a biopsy and was found to have a poorly differentiated invasive squamous cell carcinoma of the right tongue base, and PET/CT showed there was involvement of local lymph nodes as well. He was diagnosed with Stage IVA squamous cell carcinoma of his right tongue base. His case was discussed by the hospital's tumor board, and given the extent of his disease, he was deemed not to be a candidate for surgical resection. He underwent chemotherapy and radiation treatment with curative intent. His treatment was successful, however, two years later surveillance PET scan imaging revealed recurrent carcinoma. He underwent a total glossectomy, total laryngectomy and bilateral lymph node dissection, followed by radiation treatment again.

Bruit assessment

Three years after his second round of radiation treatment, the patient had a temporary loss of vision in his right eye, consistent with a transient ischemic attack. Physical examination revealed a bruit appreciated over his right carotid artery. Duplex ultrasound utilizing the XL14-3 imaging transducer was obtained to assess the right-sided bruit. In addition, Live xPlane and 3D imaging techniques were employed to further assess and quantify the severity of the lesion.

The use of the Live xPlane mode is helpful for evaluating the cartoid plaque morphology by simultaneously displaying the long and short axis, thereby decreasing examination time.

Grayscale evaluation with Live xPlane imaging revealed significant increased thickness of the distal common carotid artery with a corresponding narrowing of the lumen. **(Figure 1)**

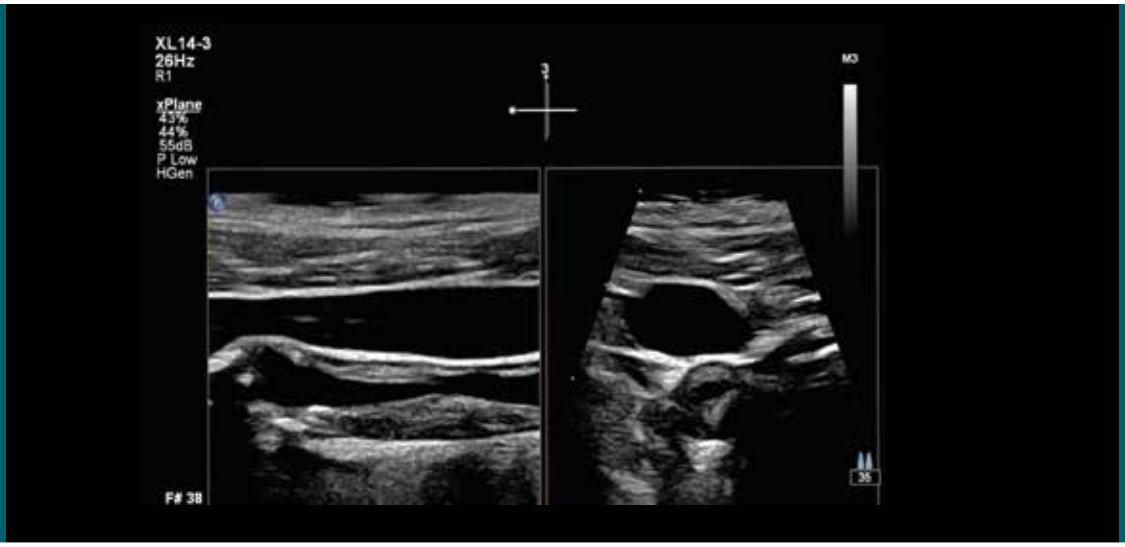

Figure 1
Grayscale with Live xPlane imaging

Figure 2
Color flow with Live xPlane imaging

Color flow evaluation with Live xPlane imaging demonstrated the residual flow lumen with increased color velocity and aliasing. **(Figure 2)**

Pulsed wave Doppler evaluation with Live xPlane imaging demonstrated an elevated peak systolic velocity of 401 cm/s and an end diastolic velocity of 115 cm/s, with a ratio of 11.4, consistent with >75% stenosis within the distal common carotid artery. **(Figure 3)** This technique assists for accurate placement of the pulse wave Doppler sample volume.

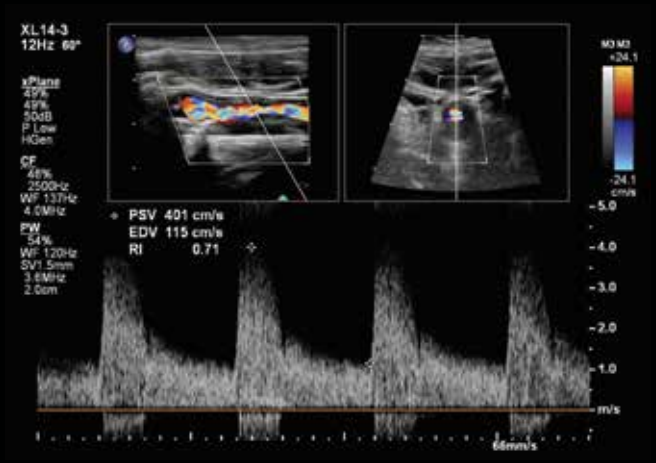

Figure 3
Pulse wave Doppler with Live xPlane imaging

Figure 4
3D rendering of the right common carotid artery displaying plaque morphology

Given the sonographic characteristics of the lesion, location and clinical history, the patient was diagnosed with radiation arteritis of the right common carotid artery. He underwent successful carotid artery stenting for the stenosis. His statin therapy was intensified, and he was switched to a more potent antiplatelet agent.

Understanding radiation-induced carotid artery stenosis

The detection of radiation-induced carotid artery stenosis is increasing due to increased use of imaging and better awareness. In a study of 71 post-radiation patients, Lam et al. found that 78.9% had extracranial artery disease. Significant stenosis (>50%) was found in 50.7% of the post-radiation patient group, vs. none in the control group of newly diagnosed patients.[1] Dorresteijin et al. found an increased risk for stroke in patients younger than 60 years who underwent radiation therapy for head and neck cancers.[2] Smith et al. 's findings support this, where the 10-year incidence of cerebrovascular events was 34% in patients treated with radiation alone compared to 25% in the surgery-plus-radiation therapy group and 26% in the surgery-only group ($p < 0.01$).[3]

The exact mechanism of radiation-induced carotid artery stenosis is not fully understood. The leading theory identifies damage to the endothelial cells, which line the inner most layer of the vessel lumen.[4] This allows for lipid infiltration, activation of lysosomal enzymes and endothelial cell proliferation.[5] Production of endothelial nitric oxide and prostacyclin, which is important for arterial relaxation, is also found to be impaired.[6] Radiation-induced injury to the microvasculature vasa vasorum can lead to necrosis and fibrosis of the vessel wall, causing vessel wall thickening. Finally, radiation treatment seems to accelerate the traditional process of atherosclerosis, mediated by well-known risk factors such as hypertension, hyperlipidemia, diabetes and tobacco use.[7]

Radiation-induced carotid artery stenosis diagnosis

The diagnosis of radiation-induced carotid artery stenosis primarily relies on clinical history and images acquired by ultrasound that allow the physician to provide a diagnosis. Auscultation for carotid bruits on physical examination is important to indicate that imaging is needed. Carotid duplex ultrasound provides an easy, noninvasive imaging modality that can help evaluate intima media thickness (IMT). An increase in the IMT in the first two years after radiation treatment may be the earliest sign of radiation-induced carotid artery stenosis.[8] Furthermore, the use of pulsed wave Doppler allows for quantification regarding the degree of stenosis. Computed tomography angiography and magnetic resonance imaging are typically used for the diagnosis of carotid arterial stenosis, however, duplex ultrasound is a more useful screening tool.[7] Improvements in duplex imaging including Live xPlane, 3-D, and 4-D techniques allow for superlative imaging and accurate diagnoses in the clinic and hospital setting.

Summary

Treatment for radiation-induced carotid artery stenosis is much like all forms of carotid artery stenosis. For symptomatic patients or patients with severe stenosis, revascularization should be considered. This is done either via carotid endarterectomy (CEA) or carotid angioplasty and stenting (CAS).[7] The role of medical management of radiation-induced carotid artery stenosis remains unclear, but the use of an antiplatelet agent with statin therapy is thought to help prevent the progression of disease.[7] The treatment of other co-morbid conditions such as hypertension, hyperlipidemia and diabetes is recommended.[7]

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