Validating common carotid stenosis by duplex ultrasound with carotid angiogram or computed tomography scan

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Background: **No consensus exists for duplex ultrasound criteria in the diagnosis of significant common carotid artery (CCA) stenosis. In general, peak systolic velocity (PSV) >150 cm/s with poststenotic turbulence indicates a stenosis >50%. The purpose of our study is to correlate CCA duplex velocities with angiographic findings of significant stenosis >60%.**

Methods: **We reviewed the carotid duplex records from 2008 to 2011 looking for patients with isolated CCA stenosis and no ipsilateral internal or contralateral carotid artery disease who received either a carotid angiogram or a computed tomography scan. We identified 25 patients who had significant CCA disease >60%. We also selected 74 controls without known CCA stenosis. We performed receiver operating characteristics analysis to correlate PSV and end-diastolic velocity (EDV) with angiographic stenosis >60%. The degree of stenosis was determined by measuring the luminal stenosis in comparison to the proximal normal CCA diameter.**

Results: **Most patients had a carotid angiogram (21/25), four only had a computed tomography angiography and four had both. Eighteen patients had history of neck radiation. The CCA PSV ≥250 cm/s had a sensitivity of 98.7% (81.5%-100%) and a specificity of 95.7% (92.0%-99.9%), CCA PSV ≥300 cm/s had a sensitivity of 90.9% (69.4%-98.4%) and a specificity of 98.7% (92.0%-99.9%). The CCA EDV ≥40 cm/s had a sensitivity of 95.5% (95% confidence interval of 75.1-99.8%) and specificity of 98.7% (92.0%-99.9%), EDV ≥60 cm/s had a sensitivity of 100% (75.1%-99.8%) and specificity of 87% (94.1-100%), and EDV ≥70 cm/s had a sensitivity of 86.4% (64.0%-96.4%) and specificity of 100% (94.1%-100%). The presence of both PSV <250 cm/s and EDV <60 cm/s had a 98.7% negative predictive value, and the presence of both PSV ≥250 cm/s and EDV ≥60 cm/s had 100% positive predictive value.**

Conclusions: **Establishing CCA duplex criteria to screen patients with significant stenosis is crucial to identify those who will need further imaging modality or treatment. In our laboratory, CCA PSV ≥250 cm/s and EDV ≥60 cm/s are thresholds that can be used to identify significant (>60%) CCA stenosis with a high degree of accuracy. (J Vasc Surg 2014;59:435-9.)**

The incidence of isolated common carotid artery (CCA) stenosis is very low (1%-5%), and little is known about the clinical course of these lesions.[1,2] It is suspected that patients with isolated CCA stenosis tend to be more symptomatic and present with amaurosis fugax, aphasia, or hemispheric symptoms.[3] Carotid duplex scanning is highly accurate in detecting internal carotid artery disease with a well-established consensus for classification of ICA stenosis.[4] However, up until today, there is no consensus whether the guidelines put by Grant et al can be applied or whether other criteria ought to be used to classify lesions in the CCA or the external carotid artery.

Most laboratories use a peak systolic velocity (PSV) of 150 cm/s with poststenotic turbulence to be associated with >50% CCA stenosis.[5] Not having a validated criteria as we do for ICA disease, could subject many patients with CCA disease to additional studies like computed tomography angiography (CTA) or carotid digital subtraction angiogram (DSA). There is only one study that correlated CCA velocities with CTA. The authors found a CCA PSV >182 cm/s to be associated with >50% stenosis with 64% sensitivity and 88% specificity.[6] The goal of our study is to correlate isolated cervical CCA duplex velocities with angiographic findings of CCA stenosis >60% using neck CTA or carotid DSA.

METHODS

We reviewed the carotid duplex records from January 2008 to December 2011 at the Michael E. DeBakey Veterans Affairs medical center in Houston, Texas. We

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identified patients with isolated CCA velocities >200 cm/s and no ipsilateral internal or contralateral carotid artery disease based on carotid duplex. We then screened for those patients who received either a neck CTA or carotid DSA within 3 months of the carotid duplex. During the same time period, we reviewed patients with CCA PSV <200 cm/s who received either a neck CTA or a carotid DSA within 3 months of the carotid duplex. This was used as the control group. The 3-month period is well within the recommended 90 to 120 days per the Commission for the Accreditation of Medical Screening Services, as long as the patient does not develop new neurologic symptoms.[7] This information is located in section 13.1.2.2.

Patients with ipsilateral ICA or CCA disease or contralateral carotid artery disease found on neck CTA or carotid DSA, not detected with the carotid duplex, were also excluded from the study. The Institutional Review Board approved the study.

Study design. Since there are no ultrasound guidelines to classify CCA stenosis, many patients with velocities >150 cm/s in our institution get another study like a CTA for further evaluation. The risk of cancer from CT scan radiation has recently been brought up as a potential serious public health problem.[8,9] In addition, it is not unusual because of higher head and neck tumors in our patient population that we get consulted for CCA disease by the plastic surgery team planning a free flap using the external carotid artery or its branches as inflow. We elected to perform this study to correlate our vascular laboratory CCA velocities with another imaging modality to help guide the treatment.

We elected to exclude patients with ipsilateral ICA, CCA, or contralateral carotid disease, based on ultrasound or angiogram, to increase the sensitivity of the study. In the study by Slovut et al,[6] the sensitivity of detecting >50% stenosis increased from 64% to 72% when these patients were excluded from the analysis. In addition, since we do not know the exact risk of stroke with CCA stenosis, we elected to choose a 60% stenosis as a first screening point to capture these patients and formulate a treatment plan. We do not necessarily treat asymptomatic 60% CCA stenosis in our practice, but it serves as a good initial screening test and formulates a treatment plan, such as performing close carotid surveillance, performing another imaging modality, or considering carotid intervention. In our practice, we consider on intervening on asymptomatic CCA stenosis >80% or symptomatic CCA stenosis >50%. Knowing that CCA velocities between 150 and 182 cm/s is associated with ~50% stenosis, we chose 200 cm/s as the initial screening velocity to increase the sample sensitivity.

Statistics. We performed receiver operating characteristics (ROC) analysis to correlate PSV and end-diastolic velocity (EDV) with angiographic stenosis >60%. We also reported sensitivity, specificity, and positive and negative predictive values. We performed Mann-Whitney *U* test and χ^2 tests to look at the demographics between the two groups. To achieve statistical significance, we made sure that the control group to experimental group ratio is 3:1. The degree of stenosis was determined by measuring the luminal stenosis in comparison with the proximal normal CCA diameter (Fig 1).

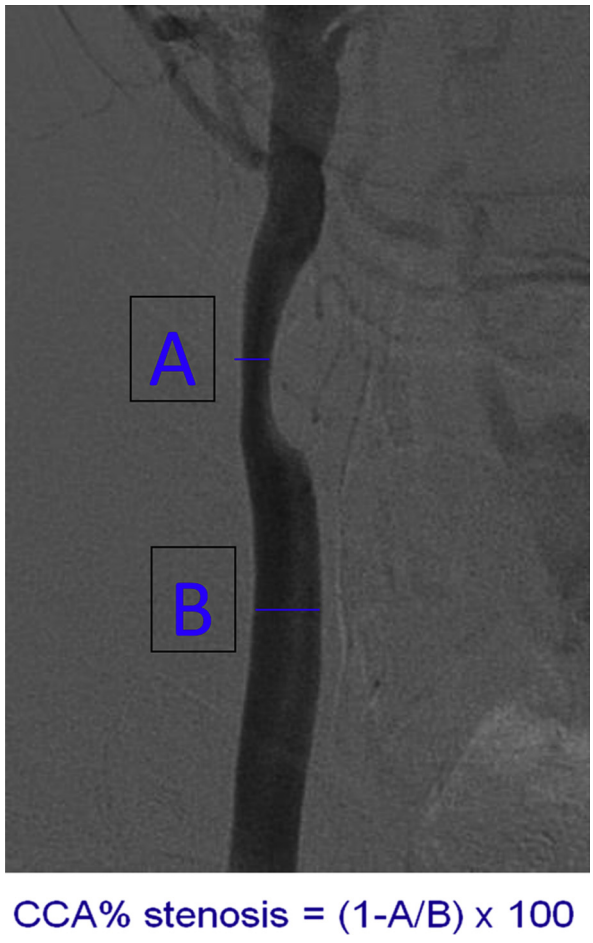

Fig 1. Method for measuring common carotid artery (*CCA*) stenosis.

RESULTS

We reviewed 112 charts in the experimental CCA stenosis group; only 25 patients met inclusion and exclusion criteria. Most of these patients had a carotid angiogram (21/25), four patients had a CTA only, and four patients had both. Eighteen (72%) patients had history of a radiated neck, and four (16%) were symptomatic at the time of the presentation. Eighteen patients (72%) were treated with a carotid stent using an embolic protection device, three (12%) underwent carotid endarterectomy, and four patients (16%) were treated medically. The majority, 14 cases, of the CCA stents were performed for asymptomatic stenosis >80%. The remaining four patients were symptomatic at the time of CCA stent, one with CCA >80% stenosis, one between 70% and 79% stenosis, and