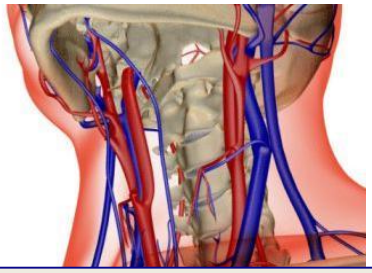
Case Study:
Asymptomatic Carotid



Carotid sonography with Doppler analysis is frequently the first line screening examination used to evaluate carotid stenosis and or plaque in symptomatic and asymptomatic patients.[1] However, there are some pitfalls with sonography that can sometimes lead to inaccurate or incomplete results. Arterial wall calcification can cause ultrasound artifacts such as dense shadowing on the gray scale image and impact Doppler velocity, which limits the accuracy of the exam. This case study shows an instance where a significant portion of the plaque exists in a "drop out" zone on the gray scale images. The net result is that the standard ultrasound results varied from MRA results. A new technique, *Visualize:Vascular™* 3D Luminal Rendering, helped in this situation.

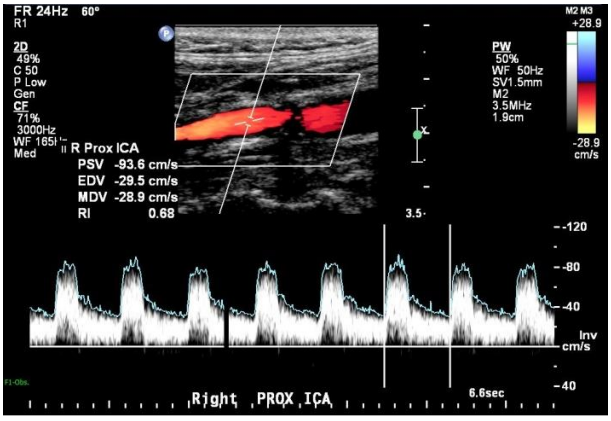
	Carotid Duplex	*Visualize: Vascular™* 3D	MRA
Luminal Reduction/ Stenosis	50-69%	85%	90%

Table 1: Comparing Left pICA Results

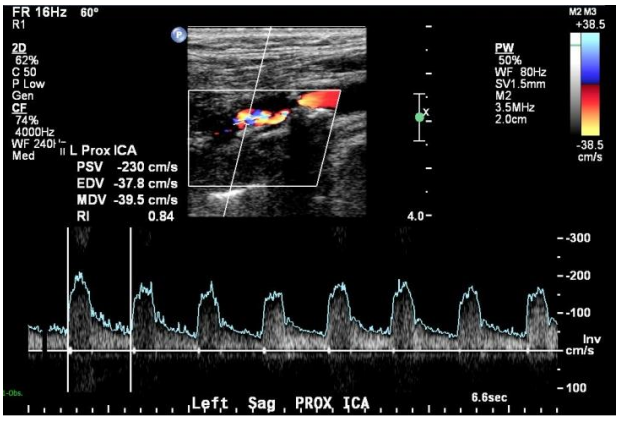
History

75 year old male with history of hypertension, some episodes of feeling faint or light headed. No history of vascular disease. Asymptomatic.

Carotid Duplex Exam



Right Proximal ICA



Left Proximal ICA

Carotid Duplex Exam (CDE) was prescribed. Doppler results are shown in Table 2. The left proximal internal carotid artery (pICA) displayed elevated peak systolic velocity (PSV), however, the region of highest diameter reduction was inhibited by the calcific shadow. The PSV is the most important spectral flow measurement as outlined in the North American Symptomatic Carotid Endarterectomy Trial (NASCET) criteria. The NASCET criteria places the relative comparison between velocities measured using Doppler ultrasound and stenosis. A pICA PSV <250 and EDV <130 is placed in the 50-69% stenosis category and PSV <150 and EDV <80 in the 1-49% stenosis category.[2] The same study recommends that a patient with >70% stenosis is referred to angiography either using Computed Tomography (CTA) or Magnetic Resonance (MRA) for a more direct calculation of luminal reduction. The NACSET guideline is that stenosis measuring above 70% should be considered for a carotid endarterectomy (CEA).

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Many surgeons would argue that in an asymptomatic individual with 70% stenosis "watchful waiting" is in order given the inherent risks of surgery.[1] The results of this CDE exam do not indicate that further imaging or a CEA were indicated.

Visualize:Vascular 3D Rendering Exam

The criteria for performing 3D rendering using ultrasound is higher grade stenosis, visible plaque, tortuosity or when following up to a prior event. The left pICA does show higher grade stenosis in the CDE and therefore 3D rendering was performed. The software package uses a transverse CINE clip of the entire carotid artery from the clavicle to the mandible to highlight the lumen and automatically find the minimum and maximum luminal diameters in 3D.

The 3D rendering procedure requires an additional scan and is a separate procedure from the CDE. Luminal reduction is calculated similar to the NASCET method. The results show a luminal reduction of >80% which is remarkably different than the CDE results.

MRA Exam

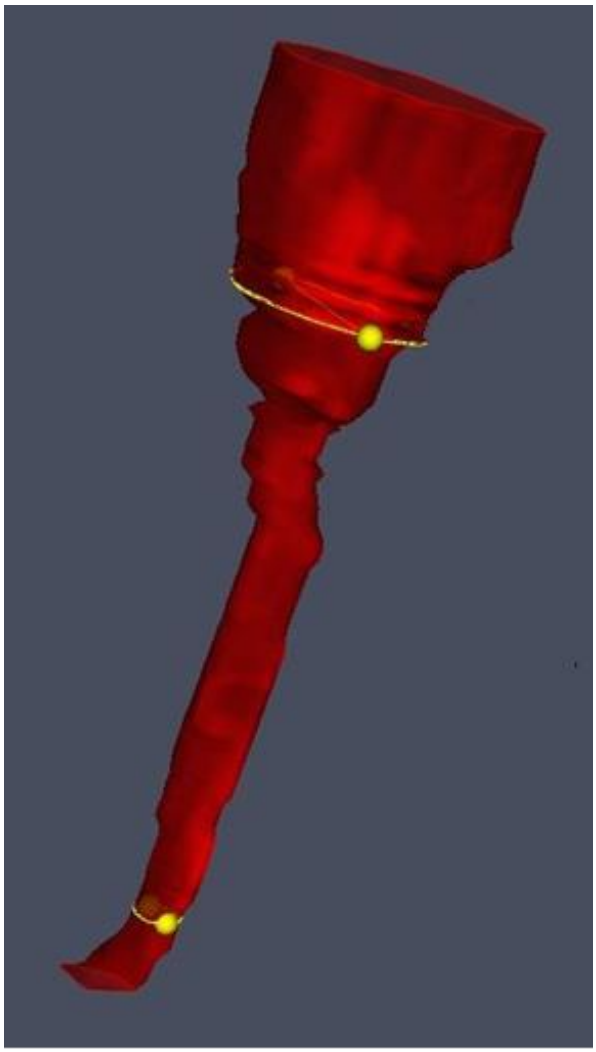
After discussing the case with the referring physician, the patient was referred for an MRA. The MRA confirmed the results demonstrated using *Visualize:Vascular* 3D Luminal Rendering.

	Right ICA proximal	Left ICA proximal
Visualize: Vascular™	24%	85%
MRA	Not significant	90%

Table 3: Concordance with MRA

CDE	Right ICA proximal	Left ICA proximal
PSV	93.6	230
EDV	29.5	37.8
MDV	28.9	39.5
RI	0.68	0.84
Stenosis	1-49%	50-59%

Table 2: Results from Cerebrovascular Duplex Exam



3D Luminal Rendering of the left pICA, showing views from 2 different perspectives. Yellow rings show the location of the maximal and minimal diameters

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CEA

A Carotid Endarterectomy (CEA) was performed on the patient. The pathology report confirms that the patient had heterogeneous plaque which significantly obstructed the pICA.

Discussion

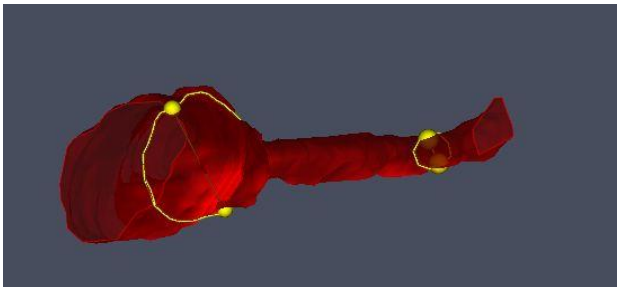
The carotid ultrasound protocol consists of capturing color longitudinal scans and Doppler velocity measurements in several places along the Common Carotid Artery (CCA), carotid Bulb, external carotid artery (ECA), internal carotid artery (ICA) and vertebral artery. The images in this case study show that there is some plaque evident in the left pICA. The question is: to what extent is the plaque present? Doppler is used to answer this question. The velocities measured using Doppler in this case study indicate that the Stenosis category is "moderate," which is later proven using MRA to be incorrect conclusion for this study. Anatomy and turbulence can cause difficulty. Being able to assess the situation with another technique could be very beneficial.

A two dimensional (2D) longitudinal scan is only able to show a 2D plane through a 3D object. There is no guarantee that a 2D plane will show either the maximal or minimal occlusion. The other imaging option is to rotate the probe to capture a transverse scan of the same area. This gives a cross section of the artery, but one transverse image also does not give a full view of the area of interest.

Three dimensional (3D) visualization uses a series of parallel transverse frames captured in a cine clip. The algorithm then segments the edge of the residual or true lumen away from the rest of the data in the image. The segmented frames are mapped together to generate the 3D rendering. The algorithm automatically finds the longest and shortest diameters, shown in yellow, and then calculates luminal reduction based on these diameters, using the NASCET technique. The results are stated in the same methodology as NASCET so that the NASCET criteria can be used to review the study and render a recommendation.[2]

Transverse frame of pICA in area with severe plaque.

***Visualize* algorithm segments the edge of the residual lumen in green.**



3D rendering of the residual lumen

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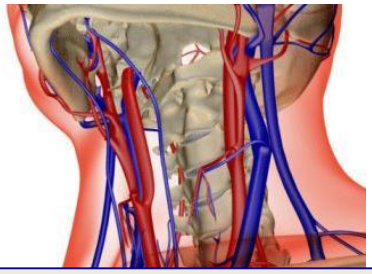

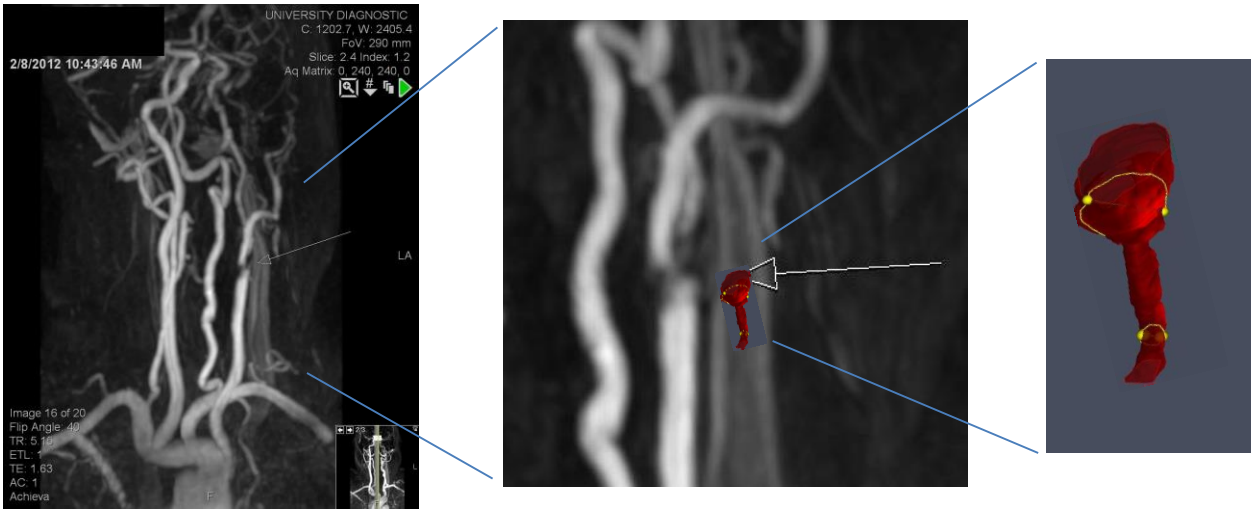

This study evidences that 3D rendering is proven to be an effective procedure through its high correlation with angiographic imaging. The MRA from this case study above shows good concordance with the 3D luminal rendering from ultrasound. 3D rendering provides a complete perspective making luminal measurements possible on ultrasound images. 3D rendering gives a much more detailed image in the area where the obstruction is present. 3D luminal rendering as provided by *Visualize:Vascular* is a very useful secondary diagnostic procedure with vascular Duplex Ultrasound.

About the Case Study

The case study is from University Diagnostic Medical Imaging, P.C., Bronx, New York.

University Diagnostic Medical Imaging ("UDMI") was founded in 1986, inspired by a vision of providing the best diagnostic imaging by experienced, board-certified radiologists. UDMI was the first full-service diagnostic radiology facility in the nation to earn all eight of the accreditations offered by the American College of Radiology. Today, UDMI is still owned and operated by radiologists who care about their patients and work collaboratively with doctors of many varied specialties to achieve the best outcome for all patients. Over the years, we have built a reputation for excellence and professionalism. We are proud of our multi cultural staff of courteous, caring professionals who are dedicated to the well being of our patients. UDMI is committed to keeping abreast of the technological advances in radiology and to incorporating them into the practice. We intend to always be at the forefront of our field. We are conveniently located at 1200 Waters Place Suite M108, Bronx NY 10461. P. 718 931 5620 F.718 824 0706

[1] Yao-Jen Chang, BA; Alexandra J. Golby, BS; Gregory W. Albers, MD, "Detection of Carotid Stenosis From NASCET Results to Clinical Practice" *Stroke.* 1995;26:1325-1328

[2] NASCET (North American Symptomatic Carotid Endarterectomy triad collaborators. Beneficial effect of carotid endarterectomy **in** symptomatic patients with high-grade carotid stenosis. *NEnglJMed*1991; 325:445-4533

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Salient Imaging

One Elm Street
Milford, NH 03055, USA
603-272-6066
www.salientimaging.com