CT Angiography's Clinical Utility Faces Hurdles

BY KERRI WACHTER
Senior Writer

WASHINGTON — Although the evaluation of noncalcified plaques with CT angiography currently is possible, there are still several obstacles to overcome before the technique is clinically useful, said Dr. Stephan Achenbach, a professor of medicine at the University of Erlangen in Germany, at the annual meeting of the Society of Cardiovascular Computed Tomography.

"As technology progresses, image quality gets better and better and our ability to visualize plaques gets better and better," said Dr. Achenbach, who also is the past president of the Society of Cardiovascular Computed Tomography.

One of the criticisms of invasive angiography is that only the lumen can be seen, not the plaque itself. Contrast CT does allow for the visualization of noncalcified plaque in the coronary arteries.

"CT is able to show it—the slight lumen reduction and also noncalcified and partly calcified plaque," said Dr. Achenbach. In fact, with high resolution, CT cross sections are similar to intravascular ultrasound (IVUS) for evaluating plaque composition. However, "this is indeed a tremendously difficult task to visualize these plaques by CT."

One reason for this is that the plaques in the coronary arteries are extremely small. The spatial resolution of CT under optimal conditions is approximately 0.4 mm. "So we're trying to visualize something that is half a millimeter thick with a spatial resolution of 0.4 mm," said Dr. Achenbach.

Another problem is contrast. Calcium is easy to see on CT because it has a very high contrast with the surrounding tissue. However, the contrast between noncalcified plaque and the surrounding tissue is much less. "So we have to deal with structures that give us very little contrast on CT," said Dr. Achenbach.

Yet another challenge in using CT to visualize noncalcified plaque is the high level of image noise. Simply put, noise is the difference between real-world signals and an ideal signal and may be caused by a wide range of sources, such as variations in detector sensitivity and environmental variations.

The combination of low contrast between noncalcified plaque and surrounding structures and high image noise makes it very difficult to tell whether noncalcified plaque is present.

"Motion is another problem," said Dr. Achenbach. Patient motion can produce blurring and dark areas that can be mistaken for noncalcified plaques.

The presence of calcium also can cause problems on occasion. Even under ideal conditions, calcium can appear to be surrounded by a dark rim. On inspection it can be unclear if this is really noncalcified plaque or not. "In the presence of calcium, we have tremendous difficulty ruling in or ruling out the presence of noncalcified plaque," said Dr. Achenbach.

Despite these problems, "if image quality is really good, we continue to be amazed by how accurately and clearly CT angiography can visualize these noncalcified plaques," he said.

Unfortunately, there are few data on the accuracy of CTA in identifying noncalcified plaque. In the studies that have been performed, researchers compared multidetector CT (usually 16-slice) with IVUS in patients without coronary stenoses. The accuracy of multidetector CT (MDCT) in the detection of nonstenotic plaque ranged from 80% to 90%. However, many of the plaques identified were at least partly calcified. The accuracy of MDCT detection of purely noncalcified plaque was closer to 50%.

Beyond plaque characterization, can CT quantify? "Theoretically, you can measure the size of the plaque and you can measure the size of the lumen," said Dr. Achenbach.

In general, the correlation between MDCT and IVUS with regard to measuring plaque area and volume is good. "But you're not really able to very accurately measure a single coronary plaque," said Dr. Achenbach.

In addition, interobserver variability is a problem when it comes to quantifying plaque using MDCT. In a study performed at his own institution, interobserver variability ranged from 19% to 32%, depending on the vessel.

The ultimate goal, though, is to be able to identify vulnerable plaques—those at the greatest risk of rupture.

Histologically, the markers of plaque vulnerability include a thin fibrous cap, a necrotic core, and macrophage infiltration. These markers are very hard to see on CT.

"However, there are some other measures that are also tied to plaque vulnerability and the [risk of it causing] an event in the future that might be amenable to CT," said Dr. Achenbach.

The remodeling index—defined as the lesion external elastic membrane (EEM) area divided by the EEM area for a reference vessel—is a potential measure. "It has been shown that the remodeling index in CT correlates quite well with the remodeling index in IVUS," said Dr. Achenbach. Strong positive remodeling has been associated with greater risk of plaque rupture.

It also is possible to measure the density—or attenuation—of plaque on CT. In a number of studies, it has been suggested that the lipid-rich plaques (considered more dangerous) have lower CT attenuation than do the fibrous plaques (which are more stable).

However, "measuring Hounsfield values is a little problematic if you want to differentiate a single plaque," said Dr. Achenbach. In addition, CT density is heavily influenced by the concentration of contrast in the lumen. As the contrast concentration increases, so does density.

Dr. Achenbach disclosed that he has received grant/research support from Siemens. He also is a consultant to Bristol-Myers Squibb Co. and a member of the speakers' bureau for Siemens and Bracco Diagnostics Inc. ■

Delay to Surgery, Gender Determine Success of Carotid Surgery

BY MITCHEL L. ZOLER
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BALTIMORE — Gender and timing are two important determinants of success that are usually ignored when surgically treating carotid artery disease. Such omissions result in subjecting patients to the risks of carotid endarterectomy despite their markedly reduced chances of benefiting from the intervention.

Women and those patients treated after several weeks' delay are much less likely to benefit from CEA than are men and those patients treated soon after a symptom (usually a transient ischemic attack), Dr. A. Ross Naylor said at the Vascular Annual Meeting.

The stroke prevention guidelines that have been issued by national health agencies and medical societies use a "one-size-fits-all" approach, said Dr. Naylor, professor of vascular surgery at the University of Leicester (England).

The validity of this approach is undermined by a careful analysis of data that were compiled from three major CEA trials that compared CEA to medical treatment only in a total of more than 6,000 patients. Data from the European Carotid Surgery Trial, the North American Symptomatic Carotid Endarterectomy Trial, and the Veterans Affairs Trial 309 were gathered for analysis by the Carotid Endarterectomy Trialists' Collaboration (Lancet 2003;361:107-16).

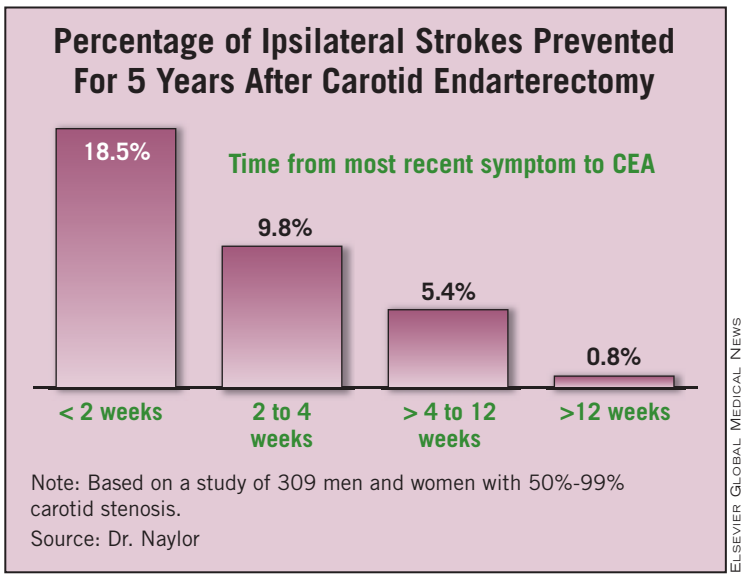
Dr. Naylor's analysis of these data showed that among symptomatic patients with 50%-99% carotid stenosis, there was a marked gradation in the rate of ipsilateral strokes prevented during 5 years of follow-up that correlated with the delay between their most recent symptom and surgery (see table).

For example, in patients who underwent CEA within less than 2 weeks of their most recent symptom, the absolute rate of ipsilateral strokes prevented was 18.5%, an "absolutely colossal" rate, he said. In contrast, in patients who had a greater than 12-week delay between their symptomatic episode and surgery the 5-year rate of ipsilateral strokes prevented was 0.8%.

"I can't think of any regulatory agency that would approve a treatment that prevented 8 out of every 1,000 events," Dr. Naylor said. "If you wait more than 12 weeks, patients face the risk of surgery but get hardly any benefit."

Many surgeons delay CEA because of the high risk of perioperative death or stroke in patients with symptomatic carotid disease. But even if surgery within 2 weeks caused a perioperative death or stroke rate of 10%, the overall, long-term reduction in strokes in these patients would be grater than if a surgeon were to perform all CEAs after 4 weeks with no perioperative deaths and strokes, Dr. Naylor said.

The danger from delaying surgery is most dramatic in women. In the analysis, women with 70%-99% stenosis had about 40% of their ipsilateral strokes prevented during 5 years of follow-up if their surgery was done within 2 weeks of symptoms. But this benefit fell steeply with any delay in CEA.



If surgery was done 2-4 weeks after symptoms, about 4% of strokes were prevented during 5 years of follow-up. When surgery was delayed beyond 4 weeks, virtually no strokes were prevented during follow-up.

Among women with 50%-69% stenosis, the only subgroup that benefited from CEA comprised those who had surgery less than 2 weeks after symptoms; in this group, CEA prevented about 10% of strokes. Women with 50%-69% stenosis who had CEA done 2 weeks or more after symptoms had an increased number of strokes, compared with untreated women.

In men, delaying surgery was less important, though CEA was still most effective when done less than 2 weeks after symptoms. In men with 70%-99% stenosis, early CEA prevented about 22% of strokes over 5 years, and in men with 50%-69% stenosis CEA within 2 weeks of symptoms prevented about 14% of strokes over 5 years.

By comparison, when surgery was delayed for more than 12 weeks, it prevented about 19% of ipsilateral strokes during 5-year follow-up in men with 70%-99% stenosis, and it prevented about 5% of long-term strokes in men with 50%-69% stenosis, Dr. Naylor said. ■