Carotid Plaque Echolucency and Risk of Stroke in Carotid Stenting

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The treatment of carotid stenosis is still controversial after more than 15 years of randomized trials and diverging opinions about the best solution between the surgical option, carotid endarterectomy (CEA), or the endovascular procedure, carotid stenting (CAS).

The endovascular approach to carotid stenosis with CAS has been proposed for years but never really had the power to replace CEA: in 2009, the Cochrane Collaborative review stated that CEA still has to be considered the treatment of choice for carotid stenosis(1).

The latest data from the CREST study showed that CAS or CEA, if randomly performed on both asymptomatic and symptomatic patients, have similar rates for periprocedural stroke, death and subsequent ipsilateral stroke and myocardial infarction, although the incidence of periprocedural stroke was lower in the CEA group rather than the CAS group whereas myocardial infarction rates were higher for the CEA group(2). On January 2011, the Circulatory System Panel of the Food and Drug Administration in the US voted in favor of an expanded indication for the RX Acculink Carotid Stent System (Abbott, Abbott Park, IL), stating the benefits of carotid stenting in patients at standard risk for adverse events from endarterectomy outweigh the risks(3).

In 2006, we stated that CAS and CEA are not equivalent and should not be alternatively proposed in the same way to every patient. Moreover, the selection of candidates for any carotid procedure based on the degree of stenosis alone does not identify correctly the real risk presented by the patient. We therefore described that the treatment of carotid stenosis should be tailored upon peculiar characteristics of each patient, such as comorbidities, vascular anatomy features and plaque morphology(4).

Plaque morphology plays an important role in order to identify patients at high risk of cerebral infarction, and therefore select the best treatment option. For the first time, in 2009 the ESVS Guidelines for the treatment of carotid stenosis underlined that plaque morphology should be assessed before any invasive treatment(5).

Several morphological features can be assessed by modern imaging techniques such as ultrasound, CEUS, Angio-CT and PET in order to characterize the vulnerable plaque. One of the most common predictors of recurrent events is plaque echolucency, obtained by duplex scanning.

Echography, assessed according to the Gray-Weale/Geroulakos classification(6,7) can reliably identify areas rich of echoes (hyperechoic or echogenic) and areas with few echoes (hypoechoic or echolucent).

Several independent authors discovered that echolucent plaques are associated with a much greater embolization rate rather than echogenic plaques, a higher grade of future neurological events and an increased presence of plaque macrophages(8-14).

Based on these findings, it’s clear that plaque echolucency reflects a histological “unstable” composition made by lipids, a thinner fibrous cap, hemorrhagic core, neovascularization and inflammatory markers.

The carotid echographic evaluation has been improved with the introduction of a computer-assisted objective grading of the echogenicity of the plaques, the GSM(15-17).

The GSM measures plaque echogenicity, a quantitative index of the echoes registered from the plaque. Low GSM plaques generate a higher number of embolic particles following CAS(18).

Many works showed that echolucent carotid plaques (with low GSM values) have higher incidence of a positive brain computed tomography for ischemic lesions, a condition related to neurological impairment and dementia, elevated serum levels of triglyceride-rich lipoproteins and lower levels of high-density lipoprotein cholesterol (HDL), higher inflammatory markers (serum interleukin-6 and C-reactive protein), and a faster plaque progression(19-28).

There is also evidence of a direct correlation between the number of particles generated during CAS and the incidence of new clinical and subclinical lesions on magnetic resonance imaging and the risk of stroke during the endovascular procedure(29,30).

With the Imaging in Carotid Angioplasty and Risk of Stroke (ICAROS) study, an international multicenter registry that collected 418 CAS cases from 11 centers, we evaluate the relationship between the echogenicity of carotid plaque, as measured by GSM, and the risk of stroke during CAS in order to obtain a better selection of candidates for CAS(31,32).

An echographic evaluation of carotid plaque with GSM measurement was made preprocedurally. The onset of neurological deficits during the procedure and the postprocedural period (30 days) was recorded. The GSM value in complicated patients was significantly lower than in uncomplicated cases, both in the stroke ($p<0.005$) and the stroke plus TIA ($p<0.005$) subsets. A receiver operating characteristic curve was used to choose the best GSM cutoff value: the most successful threshold was 25. The prevalence of a GSM value <25 (echolucent plaques) was high: 37% (155 of 418 patients). Eleven (7.1%) of the 155 patients with GSM ≤25 had a stroke compared to 4 (1.5%) of 263 patients with GSM >25 ($p=0.005$).(31).

The final message from the ICAROS study was that soft, echolucent plaques with GSM ≤25 were a relative contraindication to perform CAS. At that time, distal filter was the brain protection device (BPD) of choice. Over the last few years, several technical improvements have changed perspectives in the field of cerebral protection; proximal endovascular clamping devices have entered into our daily practice. With this solution, crossing the lesion is no longer required; operators have also gained the opportunity to completely remove embolic debris of any size or type with manual aspiration because of reverse flow.

Carotid stenting has been therefore demonstrated to be safe even with soft, echolucent plaques with GSM ≤25 (33) when treated with proximal BPDs. Together with an appropriate learning curve (34), CAS can be performed on echolucent plaques and GSM can be useful to select the best protection device for each patient.

Conclusion Indications for treatment with CAS or CEA are essential in order to perform safe and tailored procedures. Selection of candidates for CAS or CEA should be based on vascular anatomical features, comorbidities and plaque morphology. The GSM index allows the detection and stratification of echolucent, vulnerable plaques in both symptomatic and asymptomatic patients.

A low GSM value is not an absolute contraindication to CAS, but an index related to a higher risk for the procedure. When performing carotid stenting on plaques with GSM ≤25, the use of a proximal brain protection device must be considered. Echographic evaluation of carotid plaque through the GSM should always be included in the planning of any clinical trial on the endovascular treatment of carotid lesions; the management of carotid stenosis ignoring plaque morphology is no longer acceptable. Plaque echolucency is therefore an indicator of success of the procedure according to protection device and learning curve.

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