THE IMPORTANCE OF COMPUTER TOMOGRAPHY ANGIOGRAPHY IN THE MANAGEMENT OF ACUTE ISCHEMIC STROKE

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Abstract: *There are various imaging modalities for diagnosing acute ischemic stroke. However, computer tomography angiography (CTA) has the main advantage of being non invasive. We review the CTA technique and illustrate from our cases various types of lesions: vascular loops, aneurism, ulcers, and distal obstructions of internal carotid artery (ICA). CTA depicts intimately the plaque morphology. Moreover, CTA permits differentiating true occlusion from pseudo-occlusion. The degree of occlusion is evaluated with high accuracy on maximum intensity projection (MIP) reconstructions. On the other hand shaded surface display (SSD) reconstructions are used for visualizing the complete anatomy of the obstruction. We address the limitations of this technique along with possible recommendations for overcoming them. There is need for current standard revision on imaging use in vascular pathology management along with a more precise use of CTA in order to manage stroke patients cost efficient.*

INTRODUCTION

Acute ischemic stroke is one of the leading causes of morbidity and mortality worldwide with serious public health implications. Approximately 88% of acute strokes are ischemic.(1) The degree of occlusion represents an important risk factor for major cerebral-vascular accidents. Identification and plaque morphology analysis require the use of an in vivo imaging modality.(2) Initially, the North American Symptomatic Endarterectomy Trial (NASCET) criteria proposed two categories of 50-69% and 70-79% as importance.(3) Recent studies analyze the use of different degrees of occlusion between 50 and 80% on a tenth increment taking into account the presence of symptoms and associated pathology.(4) Carotid plaques result through intima accumulation of lipids, proteins and cholesterol with frequent localization at the level of internal carotid artery bifurcation. Initial studies were cantered only on digital subtraction angiography (DSA) lately this procedure being used only for endovascular therapy.(5)

PURPOSE

We review current state of the art recommendations and use of CTA in the management of acute ischemic stroke analyzing the advantages and limitations of this non-invasive imaging modality. Cost efficiency should always be taken into consideration.

MATERIALS AND METHODS

Through a case series we illustrate various types of lesions associated with the pathology of acute ischemic stroke as seen on computed tomography angiography. Also, we present plaque morphology and quantification of calcifications in different types of reconstructions.

RESULTS

Computed tomography (CT) easily detects calcifications at the level of the common carotid artery (CCA) or the internal carotid artery (ICA) along with acute ischemic stroke (AIS) or intracerebral hemorrhage (ICH). Administering a contrast media lowers the ability of plaque detection.(6)

Computed tomography angiography (CTA) is a noninvasive technique that permits a clear description of the carotid artery bifurcation with information regarding the diameter of the vessel, plaque morphology and surrounding tissue. Also it enables to ascertain other possible associated lesions such as vascular loops, aneurism and distal obstructions at the level of ICA (figure no. 1).(7)

Figure no. 1. CTA – other possible lesions: vascular loops, aneurism, ulcers, distal obstruction ICA

Using the concept of vulnerable plaque CTA is used for characterizing the plaque morphology and its composition:

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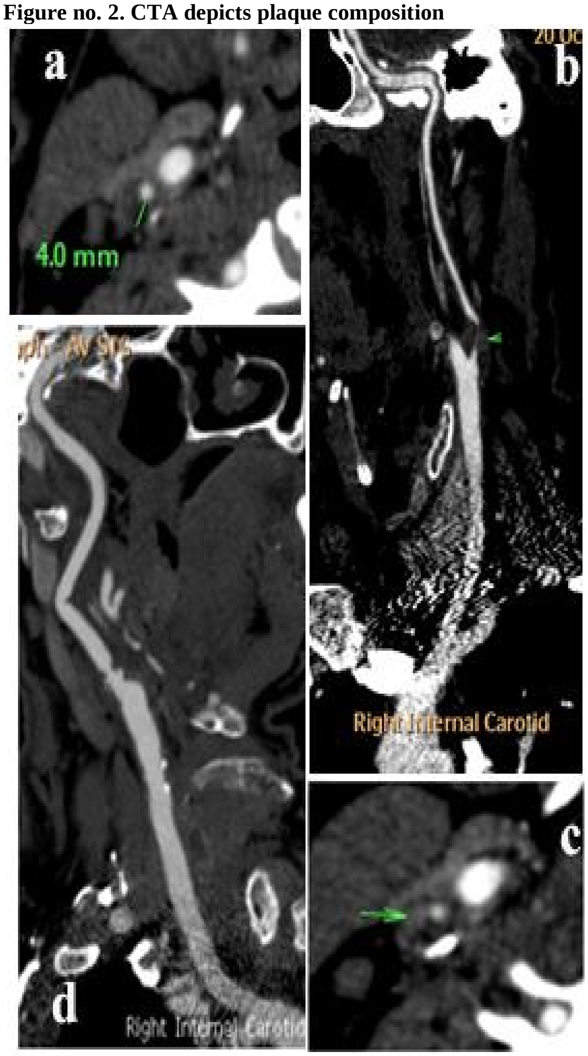
- Thickening of the carotid wall more than 4mm is predictive for future AIS (figure no. 2a).(8)
- Plaques with central lipid content with a marginal thin fibrous layer represent a high risk for AIS (figure no. 2b).
- Inflammatory changes at the level of the plaque with vasa vasorum arterial contrast uptake implies a higher risk of stroke (figure no. 2c).(9)
- On maximum intensity projection (MIP) reconstructions ulcerate plaques are detected with a sensitivity up to 94% and 99% specificity (figure no. 2d).

On the contrary, plaques with higher calcium content along with a superficial position are associated with a lower risk of stroke.(10)

Figure no. 2. CTA depicts plaque composition

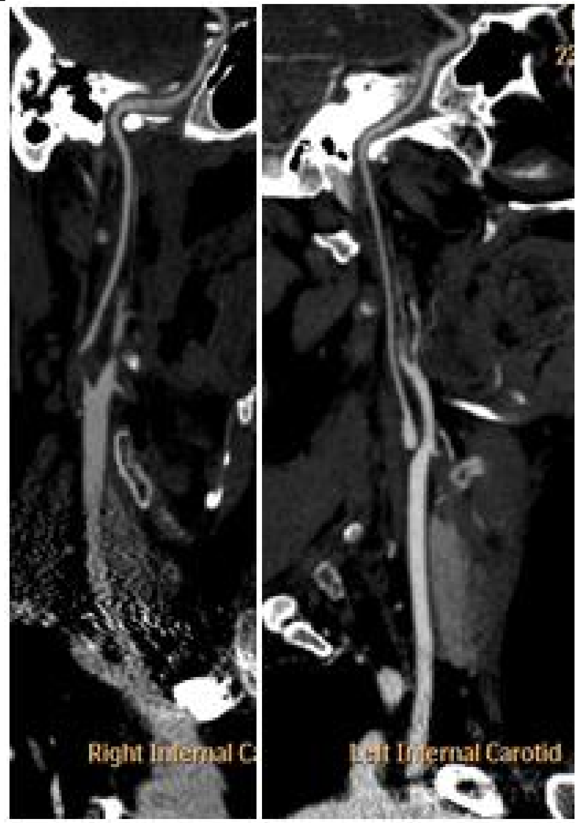


CTA is the noninvasive imaging modality with similar accuracy to DSA in indentifying true occlusion because CTA is not affected by lower blood flux and has a high spatial resolution as shown in figure no. 3.(11)

CTA precision depends moreover on the acquisition technique than on acquisition parameters.

Occlusion measurements depend on acquisition plane which is ideally perpendicular on ICA on axial sections. Axial images enable visualizing the patent lumen in spite of plaques calcifications.

Figure no. 3. CTA differentiating true occlusion from pseudo-occlusion



DISCUSSIONS

Axial sections:(12)

- Underline the occlusion without the need of further imaging processing because calcifications are not a limitation factor.
- Have the advantage of plaque morphology analysis without further imaging processing.(13)
- In the case of gross wall calcification very important is the window level in order to ascertain the residual lumen and the calcification free wall.(14)
- Regarding reconstruction techniques MIP is more accurate than shaded surface display (SSD). However, these techniques are time consuming and less accurate in case of circumferential calcifications.(15)

MIP offers angiogram-like images for a correct classification of occlusions. The imaging specialist needs to select the optimum window for every vessel analyzed (figure no. 4).

Moreover for a correct estimation of occlusion the specialist must combine MIP reconstructions with axial images (figure no. 5).

SSD reconstructions can be moved, rotated and angle adjusted with superior accuracy than DSA.

With this technique the specialist analyses the calcifications even at the level of the carotid artery bifurcation. However it underestimates the degree of occlusion given the arbitrary threshold selected.

There were cases with incorrect recordings of the vascular lumen due to short occlusion segments, in wall calcifications and the difficulty of cursor placement at tight stenosis (figure no. 6).(16)

Figure no. 4. MIP reconstructions for occlusion evaluation

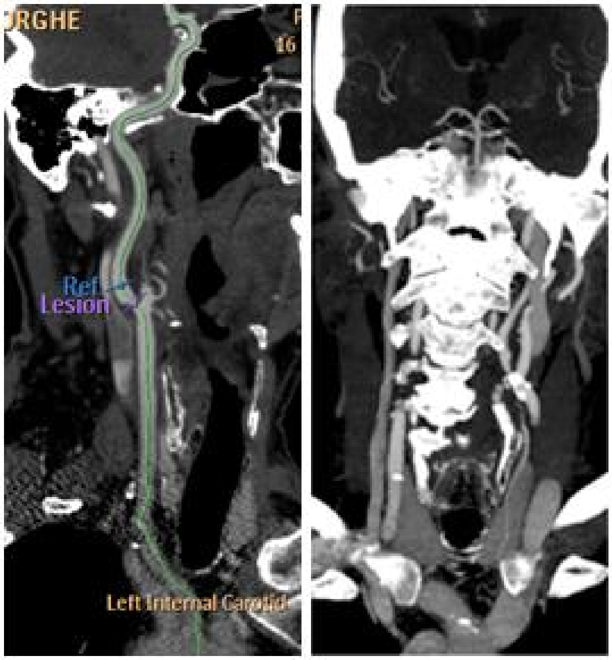
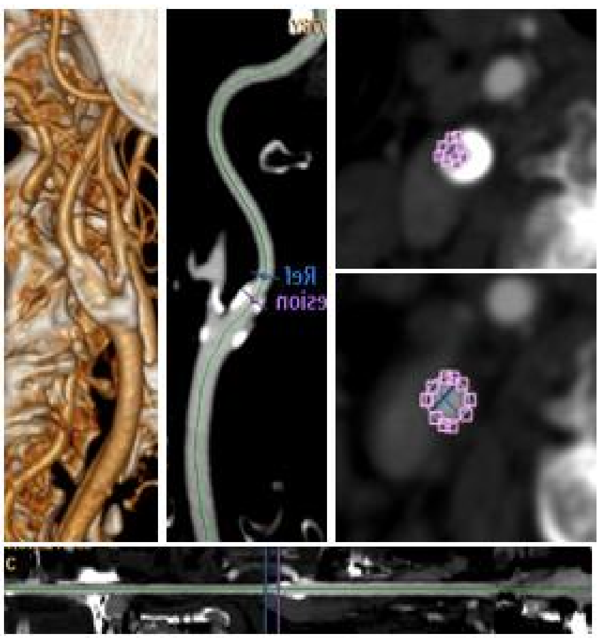


Figure no. 5. Example of combination of MIP reconstructions with axial sections



Limitations:

- The need of using techniques for lowering the irradiation dose because CTA is highly irradiating.
- Pay attention to patients with renal failure because it is forbidden to administer contrast media.(17)
- The need for post processing in order to eliminate veins and bone structures.
- Metal implants and carotid stents generate severe artifacts.(18)
- Suboptimal imaging of overweight patients.
- Movement artifacts in patients with low compliance.
- Artifacts produced by dental implants.(19)

Complete occlusion of ICA can be misinterpreted as residual flow if superimposed with the ascending pharyngeal artery.(20)

Figure no. 6. Example of SSD reconstruction at the level of occlusion

CONCLUSIONS

There is need for current standard revision on imaging use in vascular pathology management along with a more precise use of CTA in order to manage stroke patients cost efficient. The pressure on already crowded imaging departments is increased due to inefficient stroke prevention programs. However, the increased number of CT devices enables a wider access to this noninvasive imaging modality for patients with acute ischemic stroke. This aspect should be encouraged in order to identify patients at risk and grow their awareness for this silent killer. Future development of stroke centers with a wider access to invasive procedures is still lacking European wide coverage.

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