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Carotid artery stenosis: Performance of advanced vessel analysis software in evaluating CTA

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ABSTRACT

Objectives: The aim of this study was to evaluate time efficiency and diagnostic reproducibility of an advanced vessel analysis software for diagnosis of carotid artery stenosis.
Material and methods: 40 patients with suspected carotid artery stenosis received head and neck DE-CTA as part of their pre-interventional workup. Acquired data were evaluated by 2 independent radiologists. Stenosis grading was performed by MPR eyeballing with freely adjustable MPRs and with a preliminary prototype of the meanwhile available client-server and advanced visualization software syngo.via CT Vascular (Siemens Healthcare, Erlangen, Germany). Stenoses were graded according to the following 5 categories: I: 0%, II: 1–50%, III: 51–69%, IV: 70–99% and V: total occlusion. Furthermore, time to diagnosis for each carotid artery was recorded.
Results: Both readers achieved very good specificity values and good respectively very good sensitivity values without significant differences between both reading methods. Furthermore, there was a very good correlation between both readers for both reading methods without significant differences (kappa value: standard image interpretation $k = 0.809$; advanced vessel analysis software $k = 0.863$). Using advanced vessel analysis software resulted in a significant time saving ($p < 0.0001$) for both readers. Time to diagnosis could be decreased by approximately 55%.
Conclusions: Advanced vessel analysis application CT Vascular of the new imaging software syngo.via (Siemens Healthcare, Forchheim, Germany) provides a high rate of reproducibility in assessment of carotid artery stenosis. Furthermore a significant time saving in comparison to standard image interpretation is achievable.

1. Introduction

Stroke is one of the leading causes of morbidity and mortality worldwide and demographic changes will result in an increase in both incidence and prevalence [1]. With carotid artery stenosis being one of the main causes of stroke, evaluation of head and neck arteries in patients with suspected stroke is part of clinical work-up. Due to technical advances in computed tomography and image postprocessing over the last decade, CT angiography (CTA) is an established method in clinical routine [2]. However, radiologists are challenged with the continuously growing amount of CTA data [3]. Therefore it is not surprising that there is an increasing number of computer aided software tools available to assist radiologists in the process of diagnosis. Furthermore, integrated advanced visualization tools like multiplanar reformations (MPRs), maximum intensity projections (MIPs), volume rendering techniques (VRTs) and curved planar reformations (CPR) allow advanced reading and presentation of results [4–6].

The aim of this study was to evaluate time efficiency and diagnostic reproducibility of an advanced vessel analysis software for diagnosis of carotid artery stenosis.

2. Materials and methods

2.1. Patients

40 patients with known or suspected carotid artery disease who were scheduled for stent-assisted angioplasty or carotid endarterectomy were included in this study. Standardized Dual

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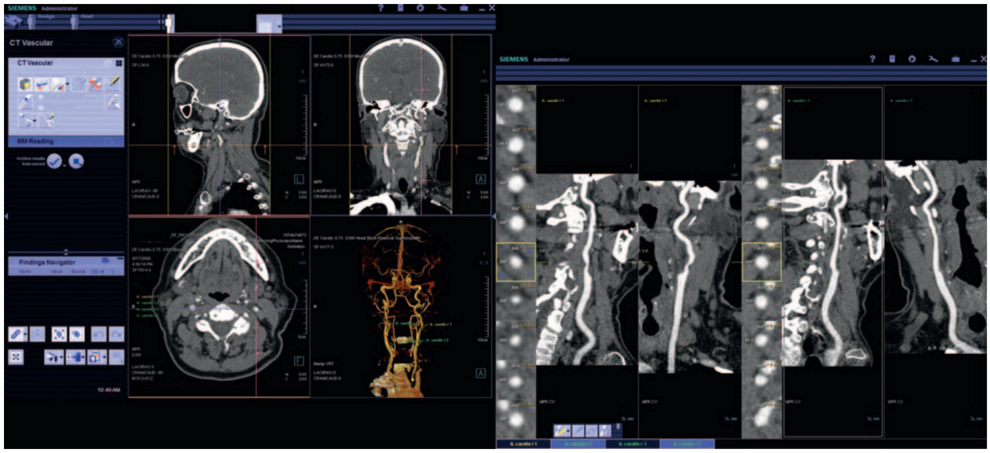

Fig. 1. Graphical user interface right after loading of case study on a dual-monitor-workplace. Carotid arteries of both sides are segmented and visualized in CPR view and cross-sectional images. Furthermore, readers can work with standard MPR-view in 3 orientations and VRT image.

Energy CTA (DE-CTA) of the head and neck arteries was performed in all patients as part of their pre-interventional workup. Elevated serum creatinine levels >1.5 mg/dl, thyroid disease, pregnancy or allergic reactions to iodinated contrast agents were determined as exclusion criteria. The local Ethics Committee approved the study protocol, and all patients gave informed consent to participate in this study.

2.2. Data acquisition and reconstruction

All examinations were performed with a dual source CT system (Somatom Definition, Siemens Healthcare, Forchheim, Germany). Contrast medium (60 ml Imeron 400 [iomeprol], 400 mg I/ml, Bracco Altana Pharma, Konstanz, Germany) was injected with a flow setting of 5 ml/s followed by a saline chaser (50 ml, flow 5 ml/s). Bolus tracking in the aortic arch was performed to assess proper filling of the supra-aortic vessels. CTA images were acquired from the aortic arch to the cranial end of the skull. DE examination was performed in a caudocranial direction, using default acquisition parameters for carotid CTA (tube A: 140 kV, 80 mAs_{ref}, tube B: 80 kV, 234 mAs_{ref}, automated tube current modulation [CareDose 4D], collimation 32 mm × 0.6 mm for each detector with flying focal spots, rotation time 0.33 s, pitch 0.65).

After examination, axial sections (1.0 mm, increment 0.6 mm) were reconstructed using a dedicated non-edge-enhancing reconstruction kernel (D30). Two individual stacks of images for each detector (80 and 140 kV images) and DE mixed images were reconstructed; the latter containing weighted information from both detectors with a weighting factor of 0.4 (40% from the 80 kV images and 60% from the 140 kV images) and thus approximating regular 120 kV images.

2.3. Image analysis

Two independent radiologists, each one with more than 3 years of reading experience evaluated all acquired CTA datasets.

First, each reader did a standard image interpretation. Therefore, all DE mixed images were anonymized and transferred to a workstation, which was equipped with a standard image interpretation software (syngo 3D, Siemens Healthcare, Forchheim, Germany). Stenosis grading for carotid arteries was performed by MPR eyeballing with freely adjustable MPRs without using measurement tools. Stenoses were graded according to the following 5 categories: I: 0%, II: 1–50%, III: 51–69%, IV: 70–99% and V: total occlusion. Furthermore, time to diagnosis for each carotid artery was recorded.

With a latency of at least 30 day, both readers repeated stenosis quantification using the advanced vessel analysis application CT Vascular of the new imaging software syngo.via (Siemens Healthcare, Forchheim, Germany, premarket version presented on RSNA 2009). All reconstructed images from tube A and B were anonymized and transferred to the imaging server. Preprocessing of the images was then performed at the server. Preprocessing

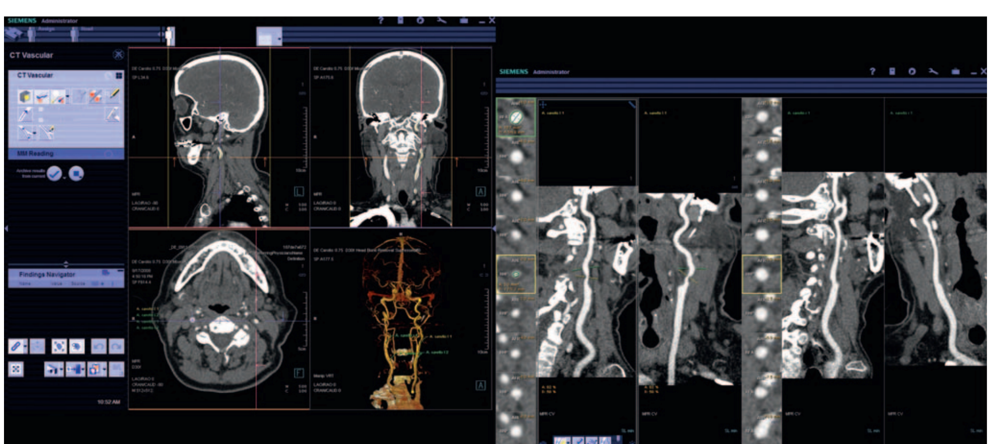

Fig. 2. Measurement of stenotic lesions. Markers are positioned via single user click. Position can be adjusted.