Carotid artery tortuosity, symptoms and stenosis degree: Are they associated? An analysis with MDCTA

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Purpose

Atherosclerotic extracranial carotid disease is the major risk factor for stroke, representing one of the leading causes of death and severe disability in the western world. In 2003, stroke accounted for about 1 of every 15 deaths in the United States.

For this reason, the study of extracranial carotid artery has a great importance to correctly stratify patients risk. Actually, there are several different imaging techniques which may be valid diagnostic tools to assess carotid artery: Ultra-Sound Echo-Color-Doppler (US-ECD), Magnetic Resonance (MR); Multi-Detector-Row Computed Tomography Angiography (MDCTA), Digital Subtraction Angiography (DSA) and Nuclear Medicine.

The parameters to be assessed during carotid study are numerous: stenosis degree quantification, identification of the specific type of plaque (fatty, mixed, calcified), characterization of plaque's stroke risk determinants (ulcerations, fissured fibrous cap, intraplaque haemorrhage). Carotid artery may be also characterized by the presence \ absence of tortuosity (on average 10-25% of population.

According to many authors, the presence of this condition, and above all the contemporary association with a kinking may represent an increased risk factor for the patient of developing a TIA/stroke even if this opinion is still debated and available data must be furtherly checked.

Purpose of this study was to evaluate whether (a) the presence of kinking and coiling of supra-aortic vessels is associated with symptomaticity (b) the presence of kinking and coiling is associated with an increased carotid artery stenosis degree.

Methods and Materials

We retrospectively studied 153 consecutive patients by using Multi-Detector-row CT for a total of 306 carotid arteries Carotid artery stenosis degree was measured according NASCET criteria. Simple logistic regression analysis was performed to determine if an independent interaction existed between, presence of vessel tortuosity, symptomaticity and carotid artery stenosis degree.

MDCT-Angiography technique We performed MDCTA examination by using a multi-detector-row spiral CT scanner. We placed patients in the supine position, with the head
tilted back in order to prevent dental artefacts on the images and to have a reproducible head position, because the degree of kinking is often dependent to head position. We instructed patients not to breathe and not to swallow. Arterial enhancement was provided by the intravenous administration of 110-130 ml non ionic-iodinated contrast material, at an injection speed of 4-6 mL/sec by using a power injector and a 18-20-gauge intravenous catheter inserted into the antecubital vein. A variable delay time, from 11 to 19 seconds, was used.

**Image Analysis.** A single experienced radiologist, blinded to the clinical information, performed all measurements of luminal stenosis and identification of vessel kinking and coiling. Carotid stenosis was graded according to North American Symptomatic Carotid Endarterectomy Trial criteria: I normal, II (1-29%) mildly stenosed; III (30-49%) and IV (50-69%) moderately stenosed; V (70-99%), severely stenosed; VI occluded. Measurements to quantify stenosis degree were made by selecting a plane perpendicular to the lumen centreline as described by Ota and colleagues. The value was calculated by comparing the diameter of stenosed segment with that of the more distal normal one, where there was no stenosis (ratio percent). Every time we found a patient with a stenosis near-occlusion, we did not apply the former described method (ratio percent) and we directly included carotids in NASCET V group. We considered **coiling** as elongation of the carotid artery in a restricted space, causing tortuosity and resulting in a C- or S- or U- shape curvature or a circular (or double circular) configuration, and **kinking** as a variant of coiling (< or Z shape), that is, an angulation of one or more segments of the ICA (acute angle with 60 degree or lesser). We generically considered **vessel tortuosity** the presence of kinking or coiling.

**Results**

We detected a total of 37 kinking (12.1%) and 20 coiling (6.5%). By using Yates’ corrected chi-square test, we observed an association between kinking and symptomaticity (p value = 0.002), but no between coiling and symptomaticity (p value = 0.037).

Logistic regression confirmed that the strongest association is present between stenosis degree and symptoms (p = 0.0001) but even kinking (p = 0.0087) and age (p = 0.001) are significantly associated with symptoms. Spearman's rho did not demonstrate correlation between the coiling (r = 0.0984) or kinking (r = -0.0816) presence and increased carotid artery stenosis degree.

**Images for this section:**
Fig. 1: MDCTA volume-rendered and Maximum Intensity Projection post-processed image clearly depicts a...
Fig. 2: MDCTA volume-rendered and Maximum Intensity Projection post-processed image clearly depicts a C-shaped coiling
Conclusion

In this work our purpose was to evaluate whether (a) the presence of kinking and coiling of supra-aortic vessels is associated with symptomaticity (b) the presence of kinking and coiling is associated with an increased carotid artery stenosis degree. Although there are several studies in literature about coiling or kinking many doubts remain about their aetiology, clinical role, and best management. Kinking of the neck arteries is a direct and frequent sequel of decreased height of inter-vertebral disks with age. A casual relationship between these anomalies and the clinical onset of neurological signs is not easy to establish, also because of the frequently concomitant atherosclerotic occlusive disease at the site of the carotid bifurcation.

The identification and distinction between carotid coiling and kinking is usually based on DSA, CT, MR or US-ECD. It is important to remember that kinking and coiling however, can trespass one into another in relation of the imaging projection, so mixed forms can be observed. Moreover, the amount of kinking or coiling can be lessened or greatened by the position of the head and uncoiled, potentially kinkable internal carotid artery in extended head can trespass in a blood flow blockage in flexed head position. In addition, authors described a potential discrepancy between angiographic/imaging features and intra-operative findings, with the angiographic/imaging feature consistently under-reading the degree of the angulation.

Results of our study suggest that kinking may be associated with symptomaticity, whereas coiling seems to be not associated. The carotid artery stenosis degree severity is not related with the presence of vessel tortuosity by supporting the theory that carotid arteries tortuosity do not develop as a consequence of vascular risk factor or atherosclerotic lesions.

References


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