Detection of Thoracic Aorta Atherosclerotic Disease Using Simultaneous Non-contrast Angiography and intraPlaque hemorrhage (SNAP) MR imaging Technique

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Introduction

Atherosclerosis is a systemic disease that leads to raised plaques within the vessel wall of major arteries like aorta, coronaries, and carotids , The thoracic aorta is one of the most common site involved. Atherosclerotic disease in the thoracic aorta has been linked to an increased risk of thromboembolic events (such as embolic stroke or ischemic bowel) and an increased risk of mortality and stroke, especially for asymptomatic at-risk patients. It is very important to reliably identify aortic plaques. But the thoracic aorta located deep in the chest, it is difficult to directly evaluate the vessel wall condition with high resolution images. In this study, new MR was optimized and evaluated for the screening of the thoracic aorta atherosclerotic plaques.

Purpose

The purpose of this study is to evaluate the SNAP technique for atherosclerosis plaque detection in patients with asymptomatic thoracic atherosclerotic disease.

Methods

Study Population

Thirty-nine subjects (21 males; mean age=71±5.8 years) from a community study (Cardiovascular Risk of Older Population [CROP]) were recruited in this study. The study protocol was approved by local institutional review board prior to the initiation of this study. The written consent forms were obtained from all subjects.

MR scan and Sequences

The thoracic aorta was scanned using a Philips 3T system (Achieva TX, Philips Medical System, Best, The Netherlands) with a 32-channel phased-array cardiac coil. Each subject was scanned using a 3D simultaneous non-contrast angiography and intra-plaque hemorrhage (SNAP)[1] and an oblique T1w TSE sequences. The imaging parameters for SNAP was: T1TFE PSIR,FOV260 × 268 mm, acquisition matrix size 148 ×186, TR 7.8ms, TE 3.8 ms, flip angle 11°, SENSE factor2, sagittal acquire, ECG, respiratory -gated , scan time 4min46sec. Plaque characterization by MRI is based on the signal intensity of plaque on T1W [2,3] (Fig. 1). The imaging parameters for T1w TSE were as follows: FOV 240 × 240 mm^2, acquisition matrix size 800 ×800, TR 1RR, TE 10 ms, flip angle 90°.

Image Analysis and Statistics

The SNAP sequence was used to directly visualize hemorrhage/thrombus in the thoracic aorta descending (TAD) vessel wall, MR TAD image were parted into three segments,arch (from the thoracic vertebra upper edge 3 to down 4), mid (from the thoracic vertebra upper edge 5 to down 7),proximal(from the thoracic vertebra upper edge 8 to down 9) (Figure 2.) We recorded incidence rate of the positive signal in TAD SNAP image, and measured the Max-VWT and intensity enhance rate (intensity of (the Max-VWT- erectormuscle / erectormuscle)) of T1W QIR wall image. Complex aortic plaques defined as _4-mm-thick, ulcerated or containing mobile thrombi are considered a major source of stroke [4]. The SNAP was optimized for thoracic aorta descending (TAD) imaging .Independent samples T-test (SPSS) statistics analysis was used to evaluate the significant difference between SNAP positive signal (with or without) and complex aortic plaques.

Result

A total of 117 segments of vessel wall in TADSNAP image were observed, The abnormal signals (positive signals subject) were found on 19.7%(23/117) of the segments: the distribution of the signal is Arch:20.5%(8/39), mid: 22.5%(9/39) and proximal: 15.3%(6/39).and a total of 36 T1W QIR 3PPS cross section acquired. For segments with and without abnormal SNAP signals, significant Max-VWT difference were found on the corresponding T1W QIR images (4.5±1.3mm, 3.4±0.6mm, p<0.05). Similarly, significant Intensity ER difference were also found (33.9%±45.6%, -2.9%±26.6%., p<0.05) (table1).

Table 1.Measure of Max-VWT, Intensity ER of T1W QIR in the thoracic aorta descending

	SNAP (n=36)		
T1W QIR(n=36）	with abnormal signal(n=18)	without Normal signal (n=18)	*P*-value(P<0.05)
Max-WT	4.5±1.3mm	3.4±0.6mm	p=0.001*
Intensity ER	33.9%±45.6%	-2.9%±26.6%	p=0.04*

Data are present as the mean ±SD Max-VWT，Intensity ER （maximal vessel wall thickness, intensity enhance rate）.

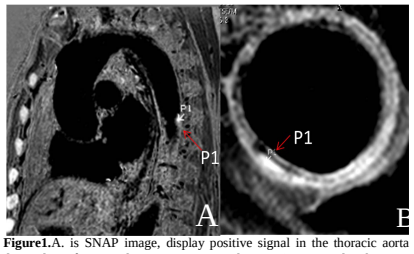

Figure1.A. is SNAP image, display positive signal in the thoracic aorta descending of proximal. B is cross-sectional T1w TSE acquired at the same location.

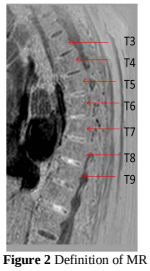

Figure 2 Definition of MR TAD sections.

Conclusions

Complicated plaque was identified in 19.7% of the subject population by SNAP. With the upper thoracic aorta being the most common site involved, as shown in this study, the optimized SNAP allows for simultaneous evaluation of complicated plaque for asymptomatic at-risk patients. SNAP positive signal was found to provide great agreement for wall thickening and intensity improved as compared to T1W QIR technique (Figure 3.). For the high sensitivity plaque detection rate, SNAP can be applied in the detection of complicated plaque in the thoracic aorta descending vessels.

References :

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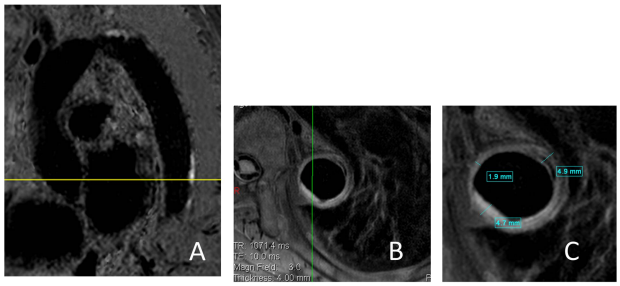

Figure3. A .is SNAP image, display positive signal in the thoracic aorta descending of proximal and Aorta arch. B. through 3PPS scout and cross section of T1W QIR acquired and high intensity of vessel wall .C. measure the MAX-VWT of T1W QIR high intensity, which is thicken and more than 4mm.