Evaluation of Distribution of Femoral Artery Atherosclerotic Disease in Asymptomatic Old Adults Using 3D MR Vessel Wall Imaging

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Introduction: Lower extremity peripheral artery disease (LEPAD), characterized as atherosclerosis in femoral arteries, will lead to ischemia or disability in the legs. In addition, it has been well-established that LEPAD is an effective predictor for future ischemic cardiovascular events [1,2]. The information of location of atherosclerotic plaques in different femoral artery segments might be useful for better understanding of natural history of LEPAD and its clinical intervention. However, the lesion distribution of LEPAD in femoral arteries remains unclear. This study sought to evaluate the distribution of femoral artery atherosclerotic disease using 3D MR vessel wall imaging.

Purpose: To investigate the atherosclerotic plaque distribution in different femoral artery segments of asymptomatic old adults by 3D MR vessel wall imaging.

Methods: Twenty-nine asymptomatic old subjects (mean age 72.8 years, range 62 to 80 years; 15 males) were recruited from a community study of Cardiovascular Risk of Old Population (CROP). All subjects underwent black-blood MR vessel wall imaging for bilateral femoral arteries at a 3.0T whole body scanner (Achieva, Philips Medical System, Best, the Netherlands) with a 32-channel cardiac coil. ***MR imaging protocol:*** the femoral arteries were imaged using 3D-MERGE (Motion-Sensitized Driven-Equilibrium Prepared Rapid Gradient Echo Sequence) sequence with the following parameters: FFE, iMSDE, TR/TE 9.1/4.2ms, flip angle 6°, FOV 250x400x60mm^3, spatial resolution 0.8x0.8x0.8mm^3. During MR imaging, two stacks (250 mm of longitudinal coverage per stack) were acquired with alignment and 40mm of overlap along femoral arteries longitudinally from the middle segment of external iliac artery to the knee. To ensure the sufficient coverage of coil when image acquisition, the cardiac coil will be repositioned from first stack to the second stack. ***Data analysis:*** The images of two acquisition stacks were fused before analysis. The MR images were interpreted by one radiologist with 3 years experience in cardiovascular imaging using custom-designed software (3D-CASCADE). The centerline was manually drawn and axial images with 2 mm thickness were resliced perpendicular to the centerline. The boundaries of lumen and outer wall for each axial image were traced. The plaque burden characteristics of femoral artery including lumen area (LA), wall area (WA), total vessel area (TVA: LA+WA), mean wall thickness (MWT), and normalized wall index (NWI: WA/TVA x 100%) were measured at each axial location. Each femoral artery was divided into four segments: common femoral artery segment (CFA), the proximal segment of superficial femoral artery (pSFA), adductor canal segment (AC), and popliteal artery segment (PA). Prevalence of atherosclerotic plaque which is defined as excentrically thickening of vessel wall was determined and compared at femoral segment. The plaque burden measurements among different femoral artery segments were also compared using One-Way ANOVA method.

Results: Of 29 subjects, 24 (82.8%) had atherosclerotic plaques in femoral arteries. Prevalence of plaques in CFA, pSFA, AC, and PA was 25.9%, 25.9%, 20.7%, and 27.6%, respectively (Fig. 1). As shown in Table 1, significant difference was found in LA, WA, TVA, and NWI among four segments (all $p<0.001$), except MWT ($p=0.068$). CFA showed the largest LA, WA, and TVA, followed by pSFA, PA, and AC. There was significant difference in LA and TVA between CFA, pSFA, AC or PA (all $p<0.05$). For WA measurement, significant difference can be observed between CFA and pSFA and AC (all $p<0.05$). PA exhibited the largest NWI ($55.2\% \pm 3.4\%$), followed by AC ($54.5\% \pm 2.7\%$), pSFA ($52.2\% \pm 3.1\%$), and CFA ($46.7\% \pm 3.3\%$) (Fig. 2). Significant difference can be found in NWI between CFA, pSFA, and AC or PA (all $p<0.05$). However, difference in all plaque burden measurements between CA and PA was not statistically significant (all $p>0.05$). We didn't find significant difference in MWT between all four femoral segments (all $p>0.05$). Fig. 3 represents an example MR image with atherosclerotic plaques in femoral arteries.

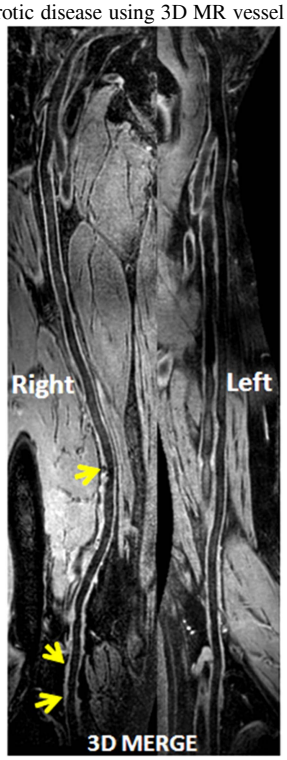

Fig. 3 Atherosclerotic plaques in AC and PA segments of right femoral artery (yellow arrows).

Table 1. Plaque burden of femoral artery.

Plaque Burden	Mean±SD				p
	CFA	pSFA	AC	PA	
LA, mm^2	52.6±10.3	33.0±6.5	27.8±5.1	28.1±7.8	<0.001
WA, mm^2	45.7±5.6	36.4±8.4	33.0±3.4	33.9±4.7	<0.001
TVA, mm^2	98.3±14.6	69.4±12.4	60.8±8.2	62.0±12.2	<0.001
MWT, mm	1.5±0.1	1.5±0.3	1.4±0.1	1.5±0.1	0.068
NWI, %	46.7±3.3	52.2±3.1	54.5±2.7	55.2±3.4	<0.001

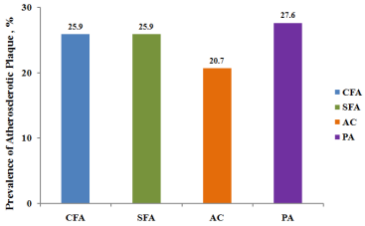

Fig. 1 Segment of Femoral Artery

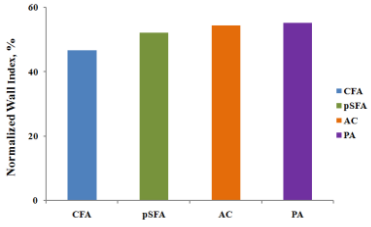

Fig. 2 Segment of Femoral Artery

Discussion and Conclusions: This study investigated the atherosclerotic plaque distribution in different femoral artery segments of asymptomatic old adults by 3D MR vessel wall imaging. We found that femoral atherosclerotic disease was prevalent in old adults, particularly in the segment of popliteal artery, common femoral artery, proximal superficial femoral artery. After normalized the natural vessel size along femoral artery longitudinally, we found that the segment of popliteal artery showed the largest plaque burden as measured by NWI among all femoral segments. A previous study demonstrated that the adductor canal segment showed greater plaque burden than bifurcation region of femoral artery in patients with LEPAD [3]. Similarly, we found that the NWI of adductor canal segment was significantly larger than that of common and proximal superficial femoral artery. It has been shown that the atherogenesis is associated with hemodynamic characteristics, particularly the lower wall shear stress. Investigators reported that the changes of blood flow patterns in adductor canal and popliteal regions during leg flexion [4] may influence the atherogenesis. However, the free-gliding mechanism of adductor canal [5] will be impaired with aging which might benefit the atherogenesis in this location. This may explain the different prevalence of atherosclerotic disease in the adductor canal and popliteal artery segments in the present study. **In summary, among all segments of femoral artery, popliteal artery segment shows the highest prevalence and burden of plaque, suggesting that more attention needs to be paid to this region in old adults for atherosclerotic disease care.**

References:

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