Symptomatic patients with mild to moderate carotid stenosis: plaque features at MRI and association with cardiovascular risk factors and statin use

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Background. In symptomatic patients with mild to moderate carotid stenosis, the balance between benefit and risk of carotid endarterectomy is small. MR imaging of carotid plaque characteristics might improve risk stratification. The objective was to assess MR plaque characteristics in this population, and to investigate associations with cardiovascular risk factors and statin use.
Methods and Results. One hundred symptomatic patients with mild to moderate carotid stenosis underwent multisequence MR plaque imaging (Figure). Carotid plaque characteristics of patients with mild and moderate carotid stenosis were assessed and compared by independent-samples T-tests and Pearson chi-square tests. Associations between plaque characteristics and clinical parameters were assessed by multivariate logistic and linear regression. Patients with moderate stenosis had plaques with a higher prevalence of intraplaque hemorrhage (IPH) (46.2% vs. 16.4%, *P*=0.001) and a thin and/or ruptured fibrous cap (FC) (61.5% vs. 36.1%, *P*=0.013), and larger lipid-rich necrotic core (LRNC) percentage (12.3% vs. 6.8%, *P*=0.042) and smaller fibrous tissue percentage (82.7% vs. 88.4%, *P*=0.024). Increasing age was positively associated with IPH (odds ratio [OR] [per year]=1.07 [95% CI, 1.01 to 1.13], *P*=0.019). Statin use was negatively associated with IPH (OR=0.28 [95% CI, 0.08 to 0.90], *P*=0.033) and a thin and/or ruptured FC (OR=0.33 [95% CI, 0.13 to 0.85], *P*=0.022), and with LRNC percentage (B=-8.17 [95% CI, -13.78 to -2.56], *P*=0.005). Statin use was positively associated with fibrous tissue percentage (B=8.08 [95% CI, 2.77 to 13.40], *P*=0.003). Other major cardiovascular risk factors were not significantly associated with plaque composition (*P*>0.05).
Conclusions. We found that symptomatic patients with moderate stenosis have a higher prevalence of complicated plaques than patients with mild stenosis. Increasing age was positively associated with IPH, whereas statin use was negatively associated with complicated plaque features. Other major cardiovascular risk factors were not associated with plaque composition, suggesting that assessment of plaque characteristics provides independent information, which might be used to improve risk stratification for stroke.

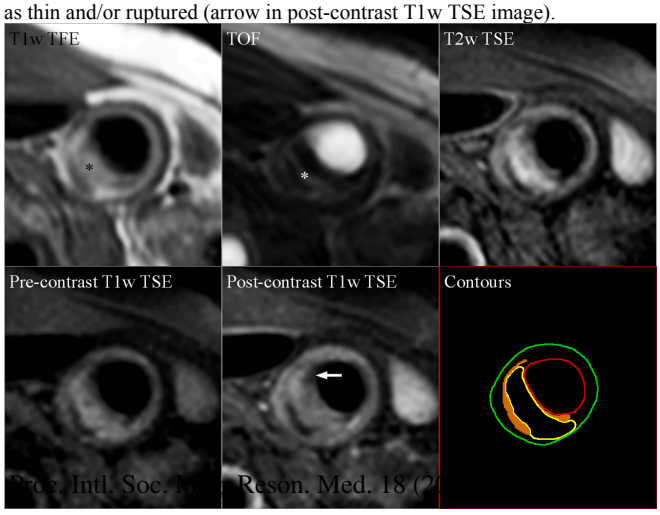
Table 1. Carotid plaque features at MRI for all patients, and for patients with mild and moderate carotid stenosis only.

Carotid plaque features at MRI	All patients (n=100) Mean ± SE or %	Patients with mild stenosis (n=61) Mean ± SE or %	Patients with moderate stenosis (n=39) Mean ± SE or %	*P*-value (mild vs. moderate stenosis)
Total plaque volume (mm^3)	1027 ± 33	1022 ± 38	1035 ± 59	0.844
LRNC (%)	9.0 ± 1.3	6.8 ± 1.5	12.3 ± 2.3	0.042
Calcifications (%)	4.8 ± 0.4	4.7 ± 0.5	5.0 ± 0.8	0.771
Fibrous tissue (%)	86.2 ± 1.2	88.4 ± 1.4	82.7 ± 2.2	0.024
Intraplaque hemorrhage	28.0%	16.4%	46.2%	0.001
Thin and/or ruptured fibrous cap	46.0%	36.1%	61.5%	0.013

Table 2. Multivariate adjusted ORs and regression-coefficients B for associations between cardiovascular risk factors and carotid plaque characteristics at MRI. Significant results are displayed in bold.

	Intraplaque hemorrhage		Thin and/or ruptured FC		LRNC (%)		Calcifications (%)		Fibrous tissue (%)	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	B (95% CI)	*P*-value	B (95% CI)	*P*-value	B (95% CI)	*P*-value
Gender (male vs. female)	0.40 (0.14 to 1.11)	0.078	0.71 (0.29 to 1.72)	0.443	-0.004 (-5.39 to 5.38)	0.999	-0.11 (-2.01 to 1.78)	0.906	0.07 (-5.03 to 5.17)	0.978
Age (per one-year increase)	**1.07 (1.01 to 1.13)**	**0.019**	1.02 (0.98 to 1.07)	0.356	0.16 (-0.12 to 0.43)	0.258	-0.13 (-0.13 to 0.06)	0.487	-0.12 (-0.39 to 0.14)	0.347
Tobacco use (smoking vs. non-smoking)	0.72 (0.21 to 2.51)	0.603	0.67 (0.24 to 1.90)	0.445	-2.14 (-8.34 to 4.06)	0.494	0.95 (-1.23 to 3.13)	0.391	1.19 (-4.68 to 7.07)	0.687
Hypertension	0.39 (0.08 to 1.85)	0.238	0.81 (0.0 to 3.30)	0.771	0.925 (-7.71 to 9.56)	0.832	0.80 (-2.24 to 3.84)	0.601	-1.74 (-9.92 to 6.44)	0.673
Diabetes mellitus	0.95 (0.28 to 3.25)	0.932	0.40 (0.13 to 1.22)	0.107	-2.10 (-8.42 to 4.22)	0.511	0.22 (-2.02 to 2.45)	0.844	1.86 (-4.12 to 7.85)	0.538
History of ischemic heart disease	2.62 (0.74 to 9.28)	0.135	1.13 (0.36 to 3.51)	0.838	3.05 (-3.66 to 9.76)	0.369	0.99 (-1.37 to 3.36)	0.406	-4.05 (-10.41 to 2.31)	0.209
Use of statins before event	**0.28 (0.08 to 0.90)**	**0.033**	**0.33 (0.13 to 0.85)**	**0.022**	**-8.17 (-13.78 to -2.56)**	**0.005**	0.13 (-1.84 to 2.11)	0.894	**8.08 (2.77 to 13.40)**	**0.003**

Figure. Co-registered T1w TFE, TOF, T2w TSE, pre- and post-contrast T1w TSE images of a transverse section of a carotid plaque. The right bottom panel displays the regions of interest which were drawn: red=lumen; green=outer vessel wall; yellow=LRNC; orange=calcifications; remaining vessel wall area=fibrous tissue. Intraplaque hemorrhage was scored as being present (asterisks in T1w TFE and TOF images) and the FC was designated as thin and/or ruptured (arrow in post-contrast T1w TSE image).



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