

Evaluation of the Relationship between the Superficial Calcification and Intraplaque Hemorrhage in the Atherosclerotic Carotid Plaque by 3T High Resolution MRI

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Introduction: High-resolution MRI has shown to be capable of detecting the components (necrotic core, intraplaque hemorrhage, etc.) of the atherosclerotic carotid plaque [1,2]. Intraplaque hemorrhage is a critical factor for the growth and destabilization of atherosclerotic plaque [3]. The rigid superficial calcification might cause the intraplaque hemorrhage during the rhythmical movement of the carotid wall. Recently, it's reported that microcalcifications in thin fibrous caps can induce plaque rupture due to stress-induced debonding [4]. In this study we aim to evaluate the relationship between the shape and location of superficial calcification and intraplaque hemorrhage in the atherosclerotic carotid plaque.

Materials and Methods : Fifty-one patients (41 males and 10 females, aged 53-90 years old) were enrolled in our study. MR sequences included double inversion recovery (DIR) fast spin echo (FSE) T1WI [TR/TI/TE: 800/650/9], cardiac gated PDWI and T2WI [TR/TE: 3RR, 20/40ms], and 3D time of flight (TOF) [TR/TE: 23/3.6]. The T1W scan was repeated ~ 10 minutes after the injection of MR contrast agent (0.1mmol/kg). Section thickness was 2 mm in T1W and 1 mm in TOF. In-plane pixel size was 0.25x0.25 mm². Inclusion criteria of the slices included: (1) ≥ 30% carotid stenosis or ≥3 mm-thickness of plaque; (2) all the plaques in the slices containing superficial calcification, which was defined as the plaque calcification directly under the fibrous cap. These slices were chosen discontinuously with at least 4mm interval to ensure the independence of the slices. Total 183 slices with superficial calcification of 69 carotid arteries were included. Intraplaque hemorrhage at the same or adjacent slice to the superficial calcification was identified with the consensus by two radiologists. The shape of the superficial calcification was categorized as nodular type and patchy type; the location of the calcification was categorized as marginal type (located in the both lateral quarters of the plaque) and central type (located in the two central quarters of the plaque) (Figure 2). Chi-Square test was used for the statistical analysis.

Results : The data that indicated the relationship between the calcification and intraplaque hemorrhage were recorded in the table below.

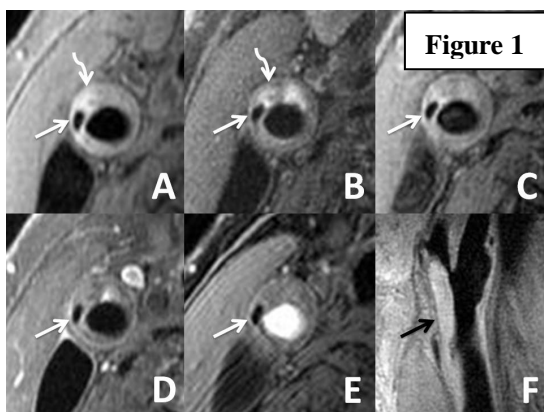


Figure 1 Superficial calcification and intraplaque hemorrhage. Nodular type of superficial calcification (white straight arrow) located in the marginal of the plaque in the distal common carotid artery (A-E; A, T1W; B, T2W; C, PDW; D, contrast-enhanced T1W; E, 3-D TOF). Intraplaque hemorrhage presents inhomogeneous hyper-intensity (white curved arrow) near the calcification. F shows carotid artery of longitudinal axis (black arrow).

Superficial Calcification	Intraplaque Hemorrhage		χ^2	P
	Yes	No		
Shape				
Nodular	115 (94.3%)	43 (70.5%)	19.481	< 0.001
Patchy	7 (5.7%)	18 (29.5%)		
Location				
Marginal	87 (71.3%)	41 (67.2%)	0.325	0.569
Central	35 (28.7%)	20 (32.8%)		

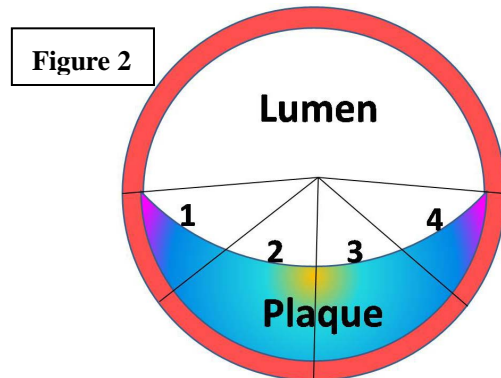


Figure 2 The location of the superficial calcification was categorized as marginal type (including area 1 and area 4) and central type (including area 2 and area 3).

Conclusion : This study showed that the nodular type of superficial calcification in the atherosclerotic carotid plaque has higher possibility of simultaneous occurrence with intraplaque hemorrhage than that of patchy type, whereas in hemorrhage group, the percentage of either marginal or central type of superficial calcification is not significantly different from that in non-hemorrhage group.

- References :**
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