Chapter 8
Plaque Erosion

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Abstract Acute coronary syndrome results from the intimal injury of an epicardial coronary artery. Plaque erosion is intimal injury which does not exhibit plaque rupture.

Pathological studies have shown that plaque erosion often develops on intimal thickening or a fibroatheroma, with few lipid core and calcification. The exposed intima at the eroded site is predominantly comprised of vascular smooth muscle cells and proteoglycans. Plaque erosions are more often observed in younger individuals and smokers compared with plaque ruptures.

There have been few angioscopic investigations of plaque erosion. Because the injured intima hides behind a thrombus, the plaque morphology is often overlooked by angioscopy. The combination of angioscopy and an intravascular imaging device visualizing cross-sectional images of an artery is thought to be helpful for identifying plaque erosion. A recent study using both angioscopy and intravascular ultrasound demonstrated that the morphologies of culprit lesions are associated with the clinical features of the patients with acute myocardial infarction. Identifying the morphology of intimal injury may help to determine the optimal management of acute coronary syndrome.

Keywords Intima • Erosion • Acute coronary syndrome

8.1 What Is Plaque Erosion?

Acute coronary syndrome (ACS) is caused by the formation or presence of a thrombus in an epicardial coronary artery. The formation of a thrombus results from intimal injury, which has a variety of morphologies. Pathological studies have shown that plaque rupture is the main morphology observed in the culprit lesions of ACS patients. Plaque rupture is defined as a perforation of a fibrous cap overlying a lipid core. Plaque rupture is not observed in approximately one-fourth

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of the patients with acute events. Plaque erosion is an intimal injury which does not exhibit plaque rupture. The ruptured site is characterized by a thin fibrous cap, large lipid core, and numerous activated inflammatory cells. On one hand, erosion often develops on intimal thickening or a fibroatheroma with few lipid core and calcification. The exposed intima at the eroded site is predominantly comprised of vascular smooth muscle cells and proteoglycans [1]. According to pathological studies, plaque erosions are more often observed in younger individuals and smokers compared with plaque ruptures [2, 3].

8.2 Angioscopic Findings of Plaque Erosion

Angioscopy can visualize the luminal surface of the intima and thrombus. The injured intima hides behind the intraluminal and mural thrombus, so the plaque morphology is often overlooked. Just after the thrombus has disappeared or decreased in size, the injured intima becomes visible. Typically, plaque erosion is diagnosed if there is only reddening and a rough surface, with no evidence of trans-cap ruptures, such as a dissection, cleft, or depressed ulceration (Fig. 8.1). Kubo et al. analyzed the culprit lesions in patients with myocardial infarction by optical coherence tomography (OCT), angioscopy, and intravascular ultrasound (IVUS). There was a significant difference in the incidence of plaque erosion diagnosed by these intravascular imaging devices (23 %, 3 %, and 0 % by OCT, angioscopy, and IVUS, respectively; $p = 0.003$). The difference in the incidence of erosion was significant between OCT and CAS ($p = 0.026$) or between OCT and IVUS ($p = 0.005$), but not between CAS and IVUS ($p = 0.500$) [4]. The combination of angioscopy and an intravascular imaging device visualizing the cross-sectional images of an artery is thought to be helpful in identifying plaque erosion (Fig. 8.2). Ozaki et al. assessed coronary CT angiographic characteristics of culprit lesions in acute coronary syndromes not related to plaque rupture as defined by optical coherence tomography and angioscopy. CT angiography revealed that a low-attenuation plaque, positive remodeling, and spotty calcification were significantly less common in the ACS not related to plaque rupture than ACS related to plaque rupture, but similar to stable angina [5].

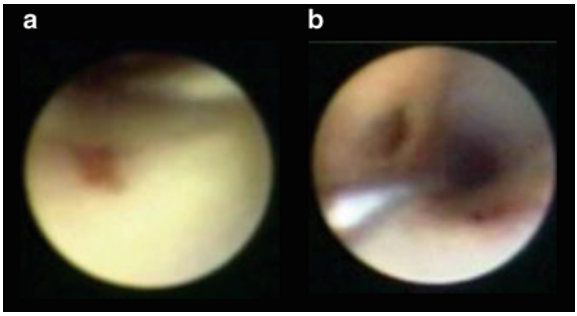

Fig. 8.1 Angioscopic finding of plaque erosion and rupture. (**a**) Plaque erosion, only reddening with no evidence of trans-cap ruptures, (**b**) plaque rupture, perforation of a fibrous cap overlying lipid core

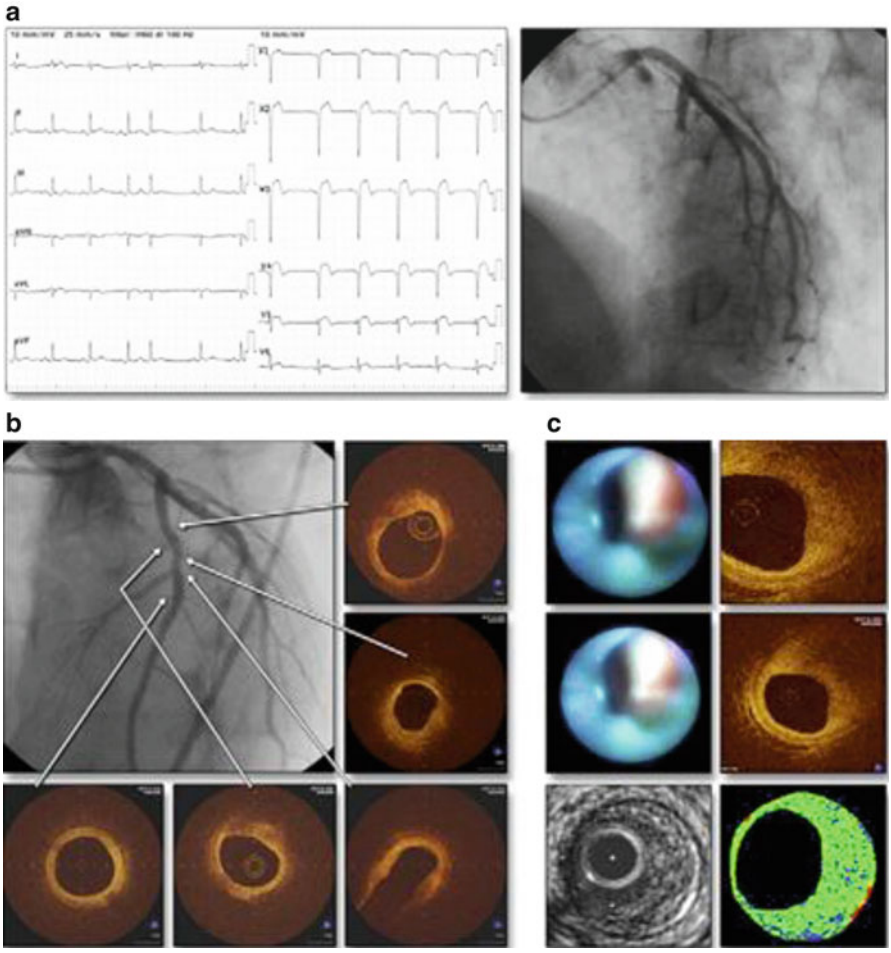

Fig. 8.2 Coronary angiography and intravascular imaging in patient with ST-segment elevation myocardial infarction not related to plaque rupture. (**a**) An electrocardiogram revealed ST-segment elevation in precordial leads. Coronary angiography showed total occlusion of the proximal segment of left anterior descending coronary artery. (**b**) Coronary angiography and OCT after thrombolysis demonstrated no significant stenosis and no perforation of fibrous cap. (**c**) Coronary angioscopy showed faint red thrombus formation through the blue coronary angioscopy guide catheter, whereas OCT did not show a typical red thrombus with a high backscattering protrusion mass with signal-free shadowing, but some signal reduction was observed from 12 to 3 o'clock positions. Intravascular ultrasound and integrated backscatter intravascular ultrasound demonstrated predominantly a fibrous plaque (*green*) and negligible lipid-rich component (*blue*) (From Prati F et al. [6])

8.3 Clinical Implications of Plaque Erosions Observed by Angioscopy

Angioscopy, which shows gross pathological findings in vivo, has the potential to clarify the differences in the pathogenic mechanisms between an erosion and rupture. Hayashi et al. examined the relationship between the morphologies of culprit lesions and the clinical features of the patients with acute myocardial infarction using coronary angioscopy and intravascular ultrasound [7]. These studies were performed immediately before percutaneous coronary intervention was undertaken. They found that the patients with eroded plaque lesions had smaller infarctions than those with ruptured plaque lesions. Furthermore, distal embolization was less frequent in the erosion group compared with the rupture group (rupture group 37.0 % vs. erosion group 0.0 %; $P = 0.0026$). These results also suggest that the morphology of the intimal injury may help to determine the optimal management of ACS. The mechanical stress caused by coronary spasm is suspected to contribute to the formation of erosion. The angioscopic findings of coronary spasm are discussed in detail in the next section.

8.4 Summary

There have been few angioscopic investigations of plaque erosion. Because a thrombus attaches to the injured intima, the morphology of the intima is often overlooked by angioscopy. The combination of angioscopy and an intravascular imaging device visualizing the cross-sectional images of the artery is thought to be helpful in identifying a plaque erosion. Identifying the morphology of the intimal injury may help to determine the optimal management of ACS.

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