Coronary artery thrombosis, due either fissuring or erosion of atherosclerotic plaque, is the usual cause of acute myocardial infarction (1) and results in a progressive increase of the infarct size with a wave-front transmural extension from the endocardium towards the epicardium (2,3). Although thrombolysis and reperfusion can occur spontaneously, thrombotic coronary artery occlusion usually persists in the majority of patients suffering an acute myocardial infarction. Thus, timely coronary artery recanalization and myocardial reperfusion, either by thrombolytic therapy or primary angioplasty and/or stenting, represents the most effective way of restoring the balance between myocardial oxygen supply and demand.

However, although beneficial in terms of myocardial salvage, the process of reperfusion may elicit itself pathologic consequences and the term “reperfusion injury” has been introduced (4-7).

The morphologic features typical of reperfused myocardial infarction will be here analyzed, i.e. contraction-band necrosis and the no-reflow phenomenon as well as the metamorphosis of acute myocardial infarction after coronary artery recanalization (Table 1).

Table 1. Pathologic features of myocardial infarction in the pre and post recanalization era

<table>
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<th>Pre-recanalization era</th>
<th>Recanalization era</th>
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<tbody>
<tr>
<td>Extension</td>
<td>Transmural</td>
<td>Subendocardial</td>
</tr>
<tr>
<td>Aspect</td>
<td>White, anemic</td>
<td>Red, haemorrhagic</td>
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<tr>
<td>Expansion and related complications</td>
<td>Frequent (aneurysm,</td>
<td>Rare</td>
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<td></td>
<td>cardiogenic shock,</td>
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<td></td>
<td>embolism)</td>
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<tr>
<td>Pericardial involvement</td>
<td>Frequent</td>
<td>Rare</td>
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</table>
During the earliest minutes of reperfusion, development of myocyte hypercontraction seems to precipitate necrosis and arrhythmias and this phenomenon ("contraction-band necrosis") has been ascribed to cardiomyocyte calcium overload. Although ischemic myocytes following reperfusion suddenly develop ultrastructural changes indicative of cell death, they are still apparently normal from an histological point of view; it is likely that most of myocytes are already irreversibly injured by the time reperfusion occurred, due to loss of plasma membrane integrity and reperfusion simply accelerates the phenomenon. The contraction-band necrosis is a frequent finding at post-mortem in sudden death victims due to atherosclerotic coronary artery disease (8). The no-reflow phenomenon refers to the absence of distal myocardial reperfusion after a prolonged period of ischemia, despite successful recanalization of the culprit coronary artery, and it appears to result from ischemia-induced microvasculature damage (9). Several functional and mechanical factors have been claimed to account for microvasculature obstruction following coronary artery recanalization, either pharmacological or mechanical, including a luminal obstruction (ie neutrophils plugging, viscosity, platelets, athero-thrombotic emboli, vasospams, endothelial swelling, etc) or an ab extrinseco compression (edema, hemorrhage, myocyte swelling). From the morphologic point of view, a lot of attention has been recently focused to the possible role of thrombotic-atherosclerotic plaque debris. Unlike most animal models of mechanical coronary occlusion, the clinical setting probably involves microembolic events in a substantial number of cases. However, a prospective randomized controlled multicenter trial on distal microcirculatory protection during percutaneous coronary intervention in ST segment elevation acute myocardial infarction, demonstrated that, although a distal balloon occlusion and aspiration system effectively retrieves embolic debris in most of the patients, this approach did not result in improved microvascular flow and overall in a better prognosis (10,11). The relevance of the microvascular obstruction due to thromboembolic material in determining the no-reflow phenomenon should be probably re-evaluated also in view of its therapeutic implications.

Finally, reperfused myocardial infarcts frequently appear reddish because of intramyocardial haemorrhage (12,13). Experimental models first showed myocardial haemorrhage in the setting of prolonged coronary occlusion and reperfusion. Then, myocardial haemorrhage after reperfusion has
been described also in humans, following cardiac surgery, percutaneous transluminal coronary angioplasty and fibrinolysis. Haemorrhagic infarcts are thought to be caused by vascular cell damage with leakage of blood out of the injured vessels. It is well known that cell vascular damage occurs after myocardial cell necrosis and thus it represents a relatively late event in the course of acute myocardial infarction at the time of already irreversible myocyte damage. Moreover, infarct haemorrhage occurs always within the area of necrosis and it is significantly related to the infarct size and to the coronary occlusion time. As such, haemorrhage is not related to the type of recanalization as it was originally thought, when it was advanced that thrombolytic therapy could play a major role. In fact, haemorrhagic infarcts can develop after percutaneous coronary interventions without thrombolysis as well. In each instance, the major determinant of hemorrhage is the time interval between the onset of coronary occlusion and the reflow, being the extent of hemorrhage increased by the delay in reperfusion. Unfavourable mechanical consequences of intramyocardial haemorrhage could consist in increased myocardial stiffness, propensity to wall rupture and delayed healing process. However, at present the clinical implications of “haemorrhagic” (red) vs “anemic” (white) infarcts remain undetermined, because of the absence of reliable and reproducible imaging modalities to detect its presence in vivo. Recently, cardiac magnetic resonance has been demonstrated to be able to detect hypointense T2 signal and susceptibility effects within the late gadolinium hypoenhanced areas which are consistent with interstitial hemorrhage due to irreversible vascular injury as proven by pathologic studies (14).

**BULLET POINTS:**

- Acute myocardial infarction following coronary artery recanalization is characterized by frequent subendocardial location, rare expansive remodelling and related complications (cardiogenic shock, thromboembolism), rare pericardial involvement
- At histology, typical features consist of contraction band necrosis and interstitial haemorrhage
- the red-haemorrhagic appearance is typical of reperfused myocardial infarction. However, it remains to be elucidated whether haemorrhagic myocardial infarction is associated with unfavourable mechanical consequences, in terms of propensity to rupture and delayed healing process

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3. Reimer KA, Jennings RB. The "wavefront phenomenon" of myocardial ischemic cell death. II. Transmural progression of necrosis within the framework of ischemic bed size (myocardium at risk) and collateral flow. Lab Invest. 1979;40:633-44.