Definitions of acute coronary syndromes

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Abstract

The Third Universal Definition of myocardial infarction (MI) and the clinical use of high-sensitivity troponins have resulted in an increase in patients recognized with a diagnosis of MI. Although the most common cause of MI remains acute coronary syndrome (ACS) caused by atherosclerotic coronary artery disease, it is increasingly important to be aware of other causes of ACS, which are likely to be seen with greater frequency as recognition of MI increases. It is essential to define the cause of ACS resulting in MI as it has profound implications for treatment strategy and prognosis.

Keywords Acute coronary syndrome; MRCP; myocardial infarction; troponin

Key points

- Recognition of myocardial infarction (MI) has improved and become more frequent with high-sensitivity troponins
- MI simply implies myocardial necrosis, and does not necessarily implicate causality
- MI can be caused by epicardial coronary plaque disease (acute coronary syndrome (ACS)) or rarer causes
- MI is most commonly caused by ACS and clinically classified into ST elevation and non-ST elevation ACS to guide treatment strategy based on clinical risk
- Rarer causes include coronary vasospasm, embolization, dissection and Takotsubo's cardiomyopathy
- Defining the cause of the MI is essential for identifying the appropriate treatment strategy

Background

The definition of acute coronary syndrome (ACS) has evolved in recent years. Early insights identified the clinical syndrome as resulting from an ischaemic insult to the myocardium caused by thrombosis and vessel occlusion related to obstructive atherosclerotic coronary artery disease; this then causes cardiomyocyte necrosis or myocardial infarction (MI).[1] Later studies focused on identifying ever more sensitive markers of this myocardial necrosis, which led to the identification of cardiac troponins. Their use is now commonplace in clinical practice in identifying MI and, in the correct clinical context, ACS.

Research over the last two decades has delineated that although coronary artery disease remains the major cause of an acute rise in troponin identifying MI, there are myriad other pathological processes other than ACS that can lead to MI. As troponin biomarkers increase the incident detection of MI, the cause of MI, be it 'classic' ACS recognized as a 'heart attack', rarer causes of ACS or non-coronary causes, should be sought to accurately define the diagnosis.

The Third Universal Definition of MI published in 2012 reflected this.[2] It divided acute MI into five types based on heterogenous pathological causes, with the classic (and most common) cause resulting from thrombotic vessel occlusion being just one type. Hence, it is useful to note that although the terms ACS and MI have evolved to be used interchangeably, the cause of troponin leak or MI may not necessarily be strictly ACS, and ACS may not strictly be occlusive epicardial coronary artery disease. This distinction and specificity in pathophysiology is essential as it has significant implications for long-term treatment plans: for example, a patient with no significant coronary artery disease noted to have a rise in troponin in the context of sepsis would be treated quite differently from a patient with an occluded coronary artery treated with angioplasty and percutaneous coronary intervention (PCI).

As rates of diagnosis of MI increase, partly because of high-sensitivity troponins improving the recognition of myocardial necrosis, the definition of ACS will become ever more critical to guide treatment.

Types of MI (based on the Third Universal Definition)

MIs can be divided into five types based purely on pathological causes, as characterized by the Third Universal Definition published in 2012 (Table 1).[2]

Type 1 MI is caused by the classically recognizable clinical entity of ACS related to atherosclerotic plaque rupture or erosion, or coronary dissection. A decrease in epicardial blood supply to a region of myocardium results in hypoxic damage and, ultimately, tissue necrosis and infarction. Type 1 MI is clinically subdivided based on symptoms, electrocardiogram (ECG) changes and biomarker evaluation to expedite appropriate triage and management. This can include early invasive coronary angiography and intervention with angioplasty and coronary stent insertion.

Type 2 MI results in myocardial necrosis and troponin leak caused by an imbalance between myocardial oxygen demand and supply. The underlying pathological mechanisms are

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Types of myocardial infarction (MI)

- Type 1 — spontaneous MI related to ischaemia caused by a primary coronary event, such as plaque fissuring or rupture
- Type 2 — MI secondary to ischaemia resulting from an imbalance between oxygen supply and demand
- Type 3 — sudden death from cardiac disease with symptoms of myocardial ischaemia, accompanied by new ST elevation or left bundle branch block, or verified coronary thrombus at angiography and/or autopsy
- Type 4 — MI associated with percutaneous coronary intervention
- Type 5 — MI associated with coronary artery bypass grafting

Table 1

heterogenous and include anaemia, tachy- or brady-arrhythmia, hypertension or hypotension, coronary artery spasm, coronary endothelial dysfunction and respiratory failure.

A rise in troponin concentration caused by myocardial necrosis is also recognized in critically ill patients and patients undergoing major non-cardiac surgery; here it may be related to cell dysfunction and damage caused by toxins, sepsis syndrome or pharmacological agents. Notably, in these patients, the epicardial vessels may be patent, but there is a 'supply and demand' mismatch leading to myocardial necrosis. Coronary artery disease may be worsening this mismatch, so a careful assessment of risk factors, cardiac symptom history and current clinical context is essential in guiding management.

Type 3 MI is defined as a typical presentation of myocardial ischaemia/infarction in which the patient dies before it is possible to detect biomarker elevation.

Two types of *type 4 MI* have been described: 4a, in which serum troponin rises after PCI, and type 4b, which relates to acute stent thrombosis.

Finally, critical elevation of troponin in association with coronary artery bypass surgery is known as *type 5 MI*.

The impact of ACS

Coronary artery disease causing ACS and MI remains one of the leading causes of death worldwide, irrespective of socioeconomic status. World Health Organization statistics estimate that 13% of the 57.1 million global deaths recorded in 2015 resulted from coronary artery disease, with over three-quarters of these taking place in low- and middle-income countries.[3] This agrees with British Heart Foundation statistics from 2015 suggesting that 14% of all deaths in men and 9% in women in the UK resulted from coronary artery disease.[4]

Troponins in recognizing MI versus diagnosing ACS

It is difficult to overstate the key role that troponins, especially high-sensitivity troponins, have played as sensitive and specific biomarkers of myocardial necrosis in recognizing MI; this has led to their incorporation as key to its definition (Table 2).[5] Apart from being needed for governance and epidemiological accuracy, the correct diagnosis of MI is essential to guide appropriate patient management and indicate risk, as myocardial necrosis as a risk factor adversely affects morbidity and mortality across all patient groups.

However, even though positive troponins help in identifying MI, correlation with ACS or an alternative cause can be clinically challenging. MI can be the first presentation of significant coronary artery disease and the result of an ACS; alternatively, it can be a coincidental finding in an alternative pathology and unrelated to ACS.

The clinical presentation of ACS is known to be variable and can include so-called 'silent' events (without overt chest pain) and classic anginal chest pains at rest through to sudden death from catastrophic cardiac ischaemia causing heart failure or cardiac arrest.

Clinical diagnosis of ACS: ST and non-ST elevation

As occlusive coronary artery disease is the most common cause of ACS, clinical classification aims at rapid identification and treatment, informed by established data and guidelines to minimize morbidity and mortality.

ACS can usually be identified clinically by a patient's history, ECG findings and highly sensitive cardiac biomarkers. Rapid diagnosis allows for earlier identification of high-risk patients and revascularization to minimize MI. Classically, patients presenting with persistent (>20 minutes) cardiac-sounding chest pain at rest who have persistent ST segment elevation in two or more contiguous leads are designated as having 'ST elevation ACS' or 'ST elevation MI' (STEMI). The degree of ST elevation depends on age and sex. Acute or evolving changes in the ST—T waveforms can be highly valuable in locating the responsible artery and the timing of the event, and in estimating the proportion of myocardium at risk. ACS maybe the result of plaque rupture and thrombosis (most commonly) impairing coronary blood supply to the myocardium, with myriad causes that can include coronary vasospasm caused by cocaine or coronary dissection, which can effectively do the same. Rarer causes include embolization of clot or septic embolization down a coronary artery related to infective endocarditis.

Patients diagnosed with STEMI are treated as a medical emergency, ideally with primary PCI; rapid intervention aiming to restore blood flow is the gold standard of treatment, unless contraindicated.[5]

Patients presenting with continuing cardiac chest pains without persistent ST elevation are designated as having non-ST elevation ACS. Where biomarker values indicating cardiomyocyte necrosis are raised, patients are said to have had a non-STEMI (NSTEMI). In these patients, new ST depression or T wave changes can occur, or alternatively the ECG can be normal. Patients with high-risk features such as significant increases in troponins and dynamic ECG changes are generally treated with an early interventional approach. Continuing chest pain refractory to medical therapy, for example intravenous nitrates, is treated with emergency angiography and PCI, if appropriate (see Further reading). Patients without elevated biomarkers and symptoms at rest are labelled as having unstable angina. With the advent of high-sensitivity troponins, this group has become smaller, but current research indicates that, compared with NSTEMI patients, it has a substantially lower risk of death (see Further reading).

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