Distinguishing myocardial infarction type 1 and type 2

Joseph S. Alpert, MD, FESC, FACC, FAHA, FACCP
Professor of Medicine, University of Arizona College of Medicine, Tucson, AZ, USA;
Editor-in-Chief, The American Journal of Medicine
Co-chair, Task Force for the Universal Definition of MI
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Criteria for Acute Myocardial Infarction

- Detection of a rise and/or fall of cardiac biomarker values (preferably cardiac troponin) with at least one value above the 99th percentile upper reference limit and with at least one of the following:
  - Ischemic symptoms
  - ECG changes of new ischemia (new ST-T changes or new LBBB)
  - Development of pathologic Q waves in the ECG
  - Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality
  - Identification of an intracoronary thrombus by angiography or autopsy
  - On occasion, minimal or no angiographic CAD may be observed
Myocardial Infarction Type 1

Spontaneous myocardial infarction related to atherosclerotic plaque rupture, fissuring, or dissection with resulting intraluminal thrombus in one or more coronary arteries leading to decreased myocardial blood flow with ensuing myocyte necrosis.

Third Universal Definition of Myocardial Infarction
Myocardial infarction secondary to ischemia due to either increased oxygen demand or decreased supply e.g. spasm, anemia, arrhythmia, hypoxemia, or hypotension. Minimal or no CAD may be observed during angiography.
Pathophysiological differentiation between type 1 and type 2 MI

- Plaque rupture with thrombus
  - MI Type 1

- Vasospasm or endothelial dysfunction
  - MI Type 2

- Fixed atherosclerosis and supply-demand imbalance
  - MI Type 2

- Supply-demand imbalance alone
  - MI Type 2
Characteristics of a type 1 MI

• Usually spontaneous in onset with discomfort developing often in morning;

• The underlying pathological process is plaque erosion, fissuring, or rupture with subsequent thrombus formation;

• Almost all STEMIIs are in this category;

• Patients usually do not present with a serious medical illness or marked arrhythmia.
Characteristics of a type 2 MI

- Onset of MI is usually in the setting of a serious medical illness, for example, respiratory failure with marked hypoxemia or a rapid tachycardia, for example, atrial fibrillation with a rapid ventricular response;
- The underlying pathophysiological mechanism is not plaque rupture or fissuring with thrombosis, but markedly increased myocardial oxygen demand or markedly decreased myocardial oxygen supply, for example, severe anemia secondary to a GI hemorrhage.
A myocardial injury is not an infarct because ischemia was not involved

- A myocardial injury is diagnosed when an abnormal cTn value is noted but the underlying mechanism of cardiac injury is not ischemia, for example, cardiac trauma.
- In many cases, for example, chronic renal failure and heart failure, the blood cTn values remain elevated rather than rising and/or falling.
Elevations of Cardiac Troponin Values because of Myocardial Injury

- Injury related to primary myocardial ischemia (MI type 1)
- Injury related to supply/demand imbalance of myocardial ischemia (MI type 2)
- Injury not related to myocardial ischemia
- Multifactorial or indeterminate myocardial injury

Third Universal Definition of Myocardial Infarction
Elevated Troponin in the Absence of Overt Ischemic Heart Disease

- Cardiac contusion, or other trauma including surgery, ablation, pacing etc
- Congestive heart failure – acute and chronic
- Aortic dissection
- Aortic valve disease
- Hypertrophic cardiomyopathy
- Tachy- or brady arrhythmias, or heart block
- Stress cardiomyopathy (takatsubo syndrome)
- Rhabdomyolysis with cardiac injury
- Pulmonary embolism, severe pulmonary hypertension
- Renal failure
- Acute neurological disease, including stroke, or subarachnoid haemorrhage
- Infiltrative diseases, e.g., amyloidosis, hemochromatosis, sarcoidosis, and scleroderma
- Inflammatory diseases, e.g., myocarditis or myocardial extension of endo-/pericarditis
- Drug toxicity or toxins
- Critically ill patients, especially with respiratory failure, or sepsis
- Burns, especially if affecting > 30% of body surface area
- Extreme exertion
Distinguishing myocardial infarction type 1 and type 2 from myocardial injury: Was the injury due to ischemia or another process?

What was the underlying pathophysiologic mechanism leading to the MI: plaque rupture or a change in MVO2 demand or supply or a non-ischemic injury?
Controversy: How Do You Recognize a Type 2 MI?

- Do you have to have ASHD to have a type 2 MI?
- Example: A 14 year old with SVT for 5 hours with a heart rate of 180 bpm with troponin elevation – Is this a type 2 MI?
- Example: A 75 year old with known ASHD hypotension and marked anemia following an upper GI hemorrhage – Is this a type 2 MI?
Myocardial injury with necrosis and with troponin release

Renal failure

Heart failure

Myocardial infarction

Rise and/or fall of troponins together with evidence of ischaemia

Non-cardiac major procedure

Tachy or brady arrhythmia syndrome

Cardiac procedure

Myocardial infarction
Defining Type 2 MI compared with a myocardial injury

Careful clinical correlation and thought are required.
Pathologic entities in the 2012 document where it may be necessary to differentiate between type 1, type 2 MI, and a myocardial injury

- Heart failure and abnormal blood troponin levels.
- Renal failure and abnormal blood troponin levels.
- Critically ill medical patients with abnormal blood troponin levels.
- Other procedures, cardiac and non-cardiac with abnormal blood troponin levels.
Conclusion

The diagnosis of type 1 MI versus type 2 MI versus a myocardial injury requires considerable, careful, and rational clinical decision making. Good clinical judgment is essential in this decision making process. Further investigation is desperately needed.
The End
Pathophysiology of Type 1 and Type 2 MI

Thrombus with ulcerated plaque

Vasospasm or endothelial dysfunction

Supply-demand imbalance

Supply-demand imbalance

MI Type 1

MI Type 2

MI Type 2

MI Type 2

Thygesen et al: Eur Heart J, JACC, Circ. 2012
The task force debate concerning type 2 MI

- The task force discussed extensively whether the presence or likely presence of CAD should be required for the diagnosis of type 2 MI.

- The task force split over this point but the majority opinion was that CAD was not necessary for a patient to have ischemic myocardial necrosis. For example, the young person with many hours of rapid tachycardia described earlier.
“In instances of myocardial injury with necrosis, where a condition other than CAD contributes to an imbalance between myocardial oxygen supply and/or demand, the term ‘type 2’ is employed. In critically ill patients, or in patients undergoing major non-cardiac surgery, elevated values of cardiac biomarkers may appear, due to direct toxic effects of endogenous or exogenous high circulating catecholamine levels. Also, coronary vasospasm and/or endothelial dysfunction have the potential to cause MI.”
Type 2 MI quote: the new document

MI associated with non-cardiac procedures with intra-operative and/or post-operative ST segment depression and elevated cTn values:

“Studies of patients undergoing major non-cardiac surgery strongly support the idea that many of the infarctions diagnosed in this context are caused by a prolonged imbalance between myocardial oxygen supply and demand, against a background of CAD...this indicates MI type 2.”
MI in the ICU:

“Elevations of cTn are common in patients in the ICU…Some elevations may reflect MI type2 due to underlying CAD and increased myocardial oxygen demand. Other patients may have elevated values of cardiac biomarkers due to myocardial injury with necrosis induced by cathecholamine or direct toxic effect from circulating toxins.”
Type 2 MI quote: the new document

MI or myocardial injury associated with CHF:

“Multiple mechanisms have been invoked to explain measurable-to-pathologically elevated cTn concentrations in patients with CHF… Type 2 may result [or other factors may be operative resulting in a myocardial injury]…It may be difficult to establish the reason for the cTn abnormality, even after… investigations.”
Myocardial injury: quote from the document

“Small amounts of myocardial injury with necrosis may be detected which are associated with heart failure, renal failure, myocarditis, arrhythmias, pulmonary embolism or otherwise uneventful percutaneous or surgical coronary procedures. These **should not be** labelled as MI or a complication of the procedures, but rather as a myocardial injury... It is recognized that the complexity of clinical circumstances may sometimes render it difficult to determine where individual cases my lie [with respect to myocardial injury vs. MI].”
Acute CHF or Pulmonary Embolism

Acute arrhythmia

Renal dysfunction

Type 1 Myocardial Infarction

PCI

Myocyte necrosis and type 2 MI
Detection of rise and/or fall of cardiac biomarkers (preferably troponin) with at least one value above the 99th percentile of the upper reference limit together with evidence of ischemia with at least one of the following:

--Symptoms of ischemia
--ECG changes of new ischemia (new ST-T changes or new LBBB)
--Development of pathological Q waves in the ECG
--Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality
--On occasion, minimal of no CAD may be seen on angiography