Vulnerable Plaque: Can we predict which plaque will lead to the next adverse cardiac event?

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Atherosclerotic coronary artery disease is a leading cause of death worldwide. The prevention of adverse cardiac events such as myocardial infarction (MI) “heart attacks” and sudden cardiac death is of central importance.

Atherosclerosis has traditionally been described as developing via a sequence of events in the artery wall along a time continuum; cholesterol-laden debris accumulates on the artery wall forming a plaque (This has a lipid core and a fibrous cap that separate it from the blood inside the artery.) progressively occluding the lumen of the artery. In this model, stenotic (narrowed) plaques that compromise the coronary arteries by more than 60%-70% place a patient at higher risk for an acute coronary syndrome. However, retrospective data including morphologic evidence, pathology studies, serial angiograms, and emerging human data are changing this view of atherosclerosis. Mounting evidence suggests that plaque progression and clinical outcome are not always correlated. This has stimulated research to identify plaques, called “vulnerable plaques”, that are likely to cause adverse cardiac events.

A description of plaques that are vulnerable to rupture, (vulnerable plaques or VPs), has emerged from anatomical and pathological research and examination of plaques that have caused acute fatal MI. Compared to stable plaques, VPs generally have a larger lipid core (>40% of total lesion area), a thinner fibrous cap (65-150 micrometers), and many inflammatory cells. Finally, there is a notable paucity, rather than an abundance, of smooth muscle cells.

The molecular and cellular biology that underlies the formation and weakening of the fibrous cap is complex, and appears to involve numerous inflammatory and enzymatic processes within the plaque itself as well as circulating inflammatory and thrombogenic mediators. In addition mechanical properties of the plaque also play a role in this process either directly or through altering the inflammatory and the enzymatic processes within the plaque.

Regardless of the mechanism, mechanical disruption of an atherosclerotic plaque, not stenosis, is the most common cause of an acute thrombotic occlusion that leads to death in patients. While four mechanisms of plaque disruption can occur, the majority (66%-75%) of acute fatal MIs are due to rupture of the fibrous cap. Another important mechanism, superficial erosion, causes about one fifth (at most, one quarter) of acute fatal myocardial infarctions. Erosion of calcium nodules and intraplaque hemorrhage are much less common as a cause of fatal myocardial infarction.

Identifying which plaques are prone to cause a heart attack or sudden death is an active area in research with great implications, as it will be the first step to designing local therapies to halt this process.

Figure 1: Vulnerable Plaque

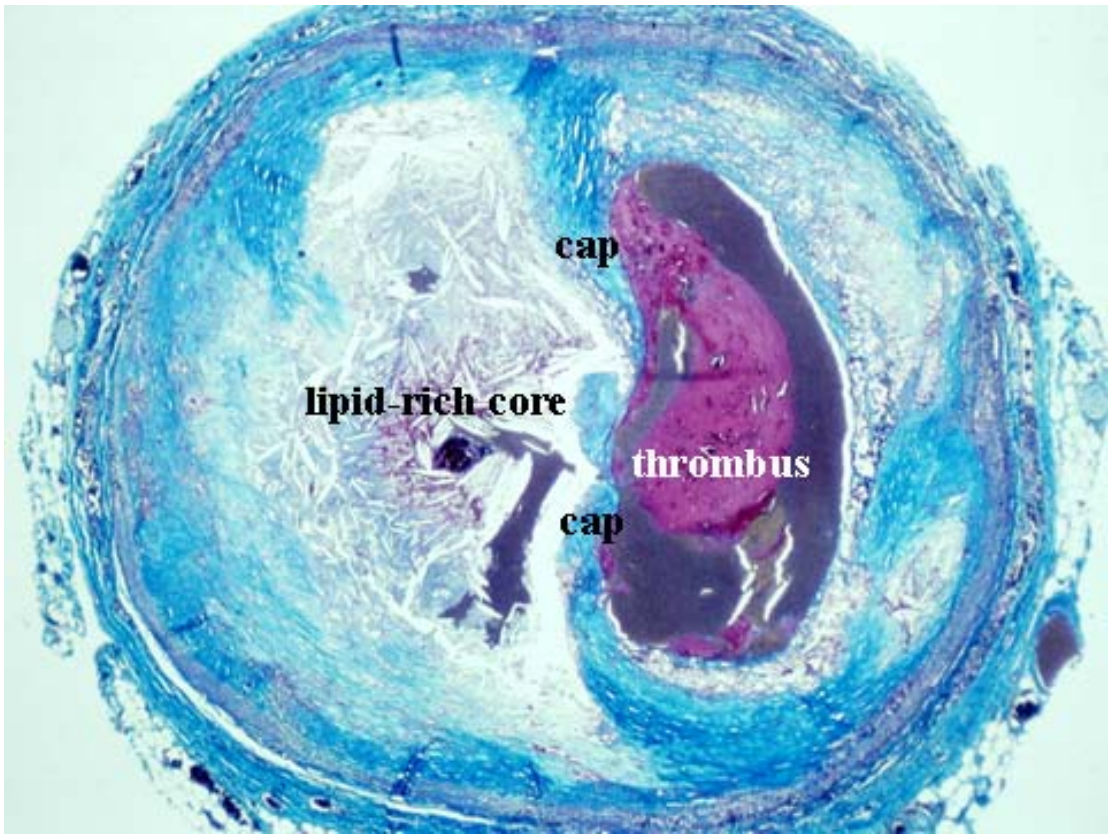
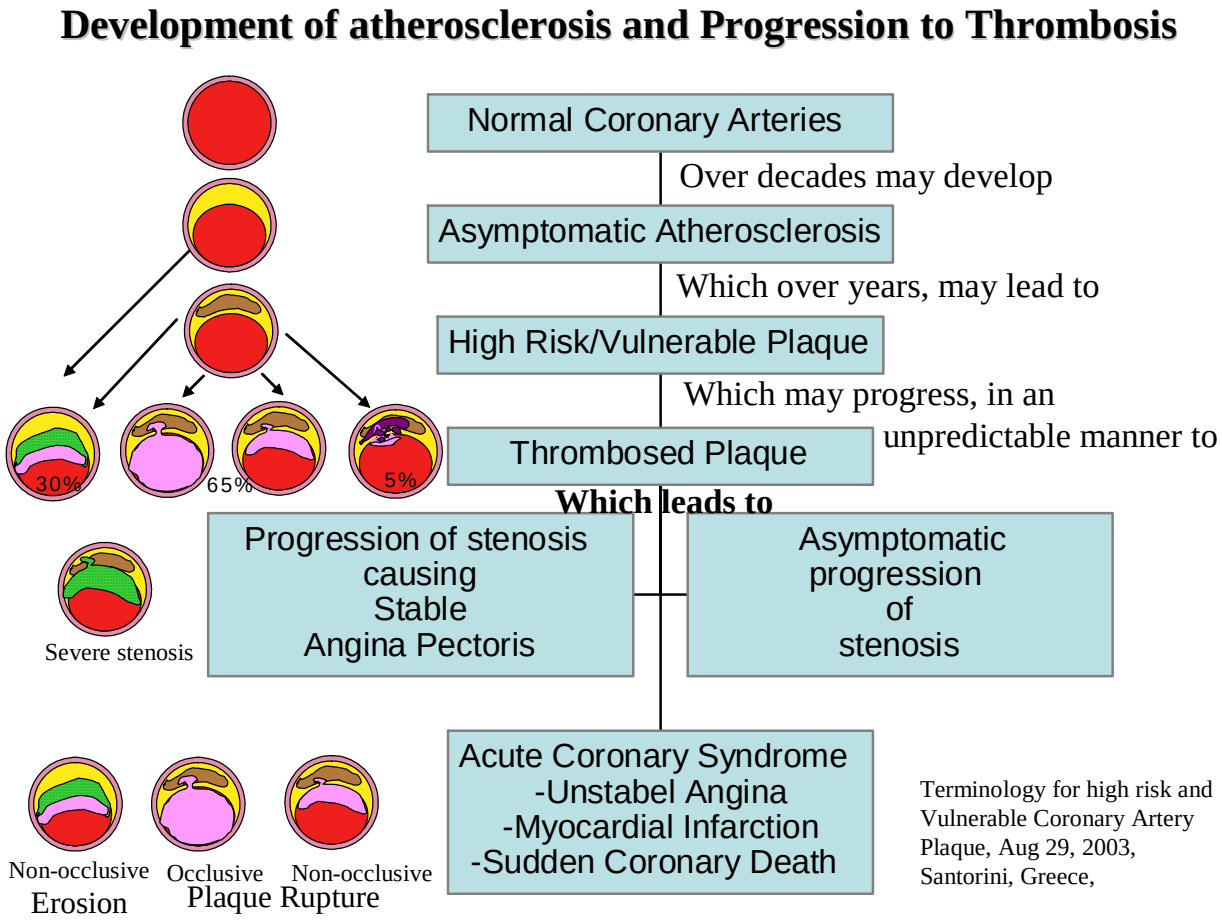


Figure 2:



Terminology for high risk and Vulnerable Coronary Artery Plaque, Aug 29, 2003, Santorini, Greece,

Reference:

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2. John A. Ambrose; In search of the “Vulnerable Plaque”: Can it Be Localized and will Focal Regional Therapy Ever Be an Option for Cardiac Prevention?
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