

Coronary artery disease, sudden death and implications for forensic pathology practice

Christopher M Milroy

Abstract

Coronary atherosclerosis is the leading cause of sudden death in developed nations. Triggers for sudden death include physical and emotional stress. At autopsy coronary artery atheroma is a common finding and may or may not be related to the cause of death. The forensic pathologist must consider the relative significance of disease, trauma and toxicological findings when determining the cause of death. This requires a consideration of evidence beyond the autopsy including the history, scene and ancillary investigations. Certain drugs including cocaine and methamphetamine are known to be atherogenic and acute and chronic use may be a factor in sudden death with underlying coronary artery atherosclerosis. Sudden death may also be associated with criminal conduct, when the scenario of "homicide by heart attack" needs to be considered. This review analyses forensic aspects of coronary artery disease.

Keywords coronary artery; forensic; forensic law; myocardial infarction

Introduction

Heart disease remains the most frequent cause of death in the developed world.¹ Coronary artery atheroma is the most frequent fatal disease process that will be encountered by the forensic pathologist at autopsy in western society and the leading cause of sudden death. It is stated someone dies of coronary artery disease every 39 seconds in the United States of America.² Diagnosis at autopsy relies on the skill of a pathologist to correctly identify pathology present and interpret it in the wider context of the death investigation. The frequency with which coronary artery disease is encountered will depend on the pattern of practice and the number of deaths and age range of decedents that are subject to post-mortem examination. Where there is a high autopsy rate, which characteristically means autopsying a larger proportion of sudden deaths in an older population, the frequency with which atherosclerotic cardiovascular disease is found will be expected to be higher. Where criteria for autopsy are more selective, it will be less often seen, though still very common because of its wide prevalence.

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For the forensic pathologist, the main issues relating to a death are in determining the cause and manner of that death. In addition the forensic pathologist can expect some of the cases to be presented in legal fora. When coronary artery atheroma is the principal finding, the cause of death is not usually an issue, but the manner may be. While most deaths will be from natural causes, coronary artery disease can be associated with other manners of death. The five manners of death are natural, accident, suicide, homicide and undetermined. Many coroners systems, such as the English Coroners system do not use manners of death, but rather conclusions (formerly known as verdicts), though the main conclusions correspond with one of the five manners of death in most cases. Other forensic issues that may need to be determined include the timing of an event, the role of drugs and role of exertion, stress and trauma in a death when there is underlying coronary artery disease. The setting of the death may also lead to the involvement of a forensic pathologist, including death in a young athlete, death in water and transportation deaths where the issue of whether the person suffered a coronary event is often raised.

The pathology of coronary artery disease in most cases is going to be established by finding stenosing coronary artery atheroma and its complications. However other conditions including arteritis, embolization and dissection may be present in a sudden death. Anomalous coronary artery circulation may also present as sudden death.

Forensic methodology

The forensic methodology involves the following steps

- History
- Scene information
- External examination
- Internal examination
- Ancillary investigations
- Opinion.

History

It is important that the history is not neglected. When considering whether a death is related to coronary artery atheroma, a history of chest pain or sudden collapse will be supportive that the coronary artery disease caused death, whereas a history of a slow decline would point away from it having a role. As an example the person who is found at autopsy to have 90% atheromatous stenosis in their right coronary artery, but was on long term pain killers and is found to have a high opioid concentration in their blood at autopsy can present a problem of interpretation.^{3,4} A history of a complaint of chest pain and then collapse would allow the pathologist to determine that the high opioid concentration represents high tolerant use with possible post-mortem redistribution rather than a death from opioid toxicity. A suicide note stating that the person had taken an overdose would direct the manner away from natural causes. Similarly a person who is found at autopsy to have 90% atheromatous stenosis in their right coronary artery and has died of a sudden collapse during an attack by another person will direct the manner in a further direction and could lead to criminal charges. In these common scenarios the coronary artery disease

process was of a similar degree, but history directs the manner of death.

Scene

The scene may provide clues to the social habits and lifestyle of the person to be autopsied and may direct the need for further investigation, such as toxicological analysis where the death may be related to both drugs and natural disease. Where a medical history is not available the scene may be the first indication that someone had heart disease with cardiac medications present.

External examination

The external examination is uninformative in many sudden natural deaths, though where there has been trauma or drug use, these may be revealed by external injury or stigmata of drug use. Collapse type injuries are most typically abrasions and lacerations to the bony prominences of the front of the face, seen commonly around the forehead, eyebrows, prominences of the cheek, chin and the nose, may provide information that there has been an unwitnessed terminal collapse and thus these injuries are supportive evidence of a sudden cardiac related death.

Internal examination

The internal examination will obviously be a central part in a death from coronary artery disease. The pathology of coronary artery atheroma and its sequelae is detailed in other papers in this issue and will not be repeated here, but organs other than the heart should not be neglected as they may provide additional information such as hypertensive changes in the kidney, or pneumonia in the lungs pointing away from coronary artery disease as the cause of death.

Ancillary investigations

The ancillary investigations most commonly performed are histology and toxicology. The decision to perform toxicology will vary between different jurisdictions, with many medical examiners offices doing routine toxicology and other jurisdictions only doing directed toxicology. Other testing may be performed including microbiology and vitreous biochemistry. Molecular testing is becoming a reality in post-mortem diagnosis, but at present is mainly directed towards identifying some cardiomyopathies specifically channelopathies such as the long QT syndromes.^{5,6}

Opinion

The amount of analysis recorded in the opinion and what is required will vary depending upon the nature of the case, the jurisdictional requirements and anticipated use of the report in subsequent legal proceedings. In identifying what factors are relevant to determining a cause of death, three factors may variably interact. These are natural disease, trauma and toxicological findings. This article looks at these three areas that relate to forensic pathology.

Is coronary artery disease the cause of death?

Many deaths will have evidence of coronary artery disease at autopsy and coronary artery atheroma, or similar wording such as atherosclerotic cardiovascular disease will be given as the cause of death. In cases where there is rupture of a myocardial

infarct there will be no question but that the rupture was the cause of death. In other cases less evidence of an acute event is present and so more consideration needs to go into determining what the cause of death was. The problem of when coronary artery atheroma is the cause of death can be illustrated by the two people who are on adjacent autopsy cases and both have 80% atheromatous stenosis of the coronary arteries. One of the victims has shot himself and the other was simply found dead in bed. No one would ascribe death to coronary artery disease in a person who shot himself, but pathologists recognize 80% stenosis of a coronary artery as a cause of sudden death. The question therefore is when is it reasonable to give coronary artery disease as the cause of death when the only evidence is stable chronic heart disease. The amount of ancillary investigations and especially the amount of toxicology performed will depend upon investigative information and also on budgetary concerns. The younger the person, the more reasonable it may be to conduct additional testing, when there is an absence of information to further direct the investigation.

Microscopic examination of the coronary arteries may assist in determining whether there have been acute changes. The most common findings that will assist in a conclusion that death was due to acute coronary artery atheroma are plaque haemorrhage and acute thrombosis [Figure 1]. While these can be seen with the naked eye, differentiating acute from older thrombus is not always possible and acute plaque haemorrhage often requires microscopic analysis for correct identification. Microscopic examination of the myocardium may show acute infarction not macroscopically visible, but often there will be no acute changes.

One useful technique to assist the examination of coronary arteries is to dissect them off the heart, fix then in formaldehyde and then decalcify them before sectioning. Where changes in the coronary arteries are critical to the medico-legal issues in the case, consideration should be given to blocking all parts of the main arteries to look for such changes as plaque haemorrhage and small thrombi.

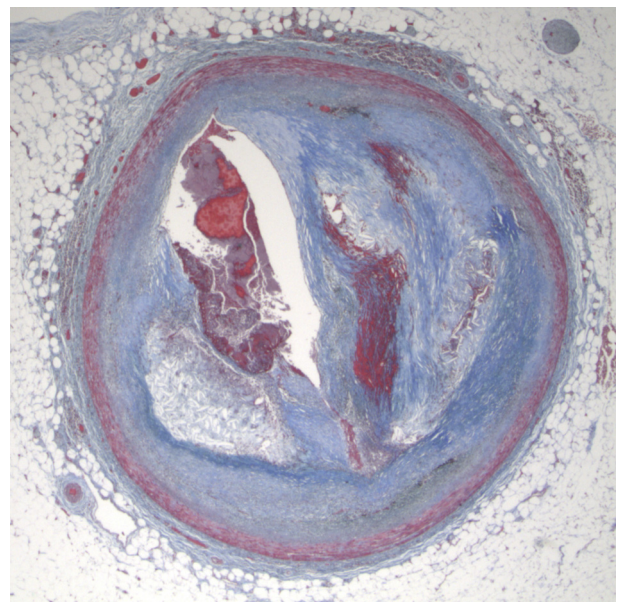


Figure 1 Coronary artery with atheroma, plaque haemorrhage and acute thrombosis (Masson trichrome).

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