The risk of coronary sudden death in the young: a pathology overview

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In contrast to the adult, coronary disease is an infrequent cause of sudden death in the young. As might be expected, coronary disease in the young is frequently caused by congenital anomalies, as opposed to acquired conditions such as atherosclerosis in the adult. In addition, the type of coronary atherosclerosis that is seen in young patients, when it does occur, tends to differ from that seen in patients over 40 years of age. The largest group of sudden cardiac death under the age of 20 is unexplained arrhythmia in the absence of morphologic abnormality in the heart at autopsy. In the state of Maryland, sudden cardiac death in the < 20 age groups occurs in approximately 2/100,000 population yearly, which is compared to a rate of over 100 per 100,000 for sudden infant death syndrome. Of sudden cardiac deaths occurring < 20 years, a coronary etiology is found in less than 10%, in the form of anomalous origin of the coronary arteries. Therefore, the risk of sudden coronary death in individuals under age 20 is quite small, <0.2/100,000 incidence, and is due to ectopic origin of coronaries. Other major causes of sudden cardiac death in this age range include structural congenital heart disease and myocarditis.

In the age range of 20-40 years, the incidence of sudden cardiac death is about four times greater than in the <20 year-old age group, with a higher rate of coronary disease. The rate of congenital coronary artery anomalies and idiopathic arrhythmias remains about the same as in the age range <20 years, but the proportion of these as the overall total drops significantly, to <5% and about 20%, respectively. The most common cause of coronary disease is atherosclerosis, with a small number of idiopathic coronary artery dissections at a similar to rate to anomalous origin. The overall most common cause of sudden cardiac death in the 20-40 year-old age range is cardiomyopathy, slightly higher than coronary atherosclerosis.

There are 3 anomalies that represent most sudden coronary deaths under age 20 years. The left main coronary artery arises from the pulmonary trunk in 1/50,000 to 1/300,000 autopsies, representing 0.25 to 0.5% of congenital heart disease. There is a female
predominance of 2:1. Most cases are identified in the first year of life, and sudden death occurs in approximately 40% of cases. Sudden death usually occurs at rest, but may occur after strenuous activity in older children. The aberrant artery arises in the left pulmonary sinus in 95% of cases. Typically, the artery appears thin-walled and vein-like, and the right coronary artery, while normal in location, is tortuous. The heart is typically enlarged, with extensive scarring and thinning of the anterolateral left ventricular wall and anterolateral papillary muscle. Dilatation of the left ventricle with endocardial fibroelastosis is common, and the gross appearance of the heart may mimic dilated cardiomyopathy.

The second anomaly, which is the common coronary anomaly resulting in sudden death in adults, is an aberrant left main arising in the right coronary sinus of Valsalva. There is a male/female ratio of 4:1 - 9:1. Sudden death occurs in up to 2/3 of patients with this anomaly, 75% of which occur during exercise. Most patients are adolescents or young adults, although death may occur as young as 1 month of age. There are often premonitory symptoms of syncope or chest pain, but stress electrocardiograms and stress echocardiograms are often negative. The ectopic ostium is typically near the commissure, and in some cases actually lies above the commissure between the right and left sinuses. Often, the ostium is somewhat malformed and slit-like, and an ostial ridge is present. The proximal artery lies within the aortic media and may be compressed during diastole. In most cases, and virtually all cases of sudden cardiac death, the aberrant artery passes between the aorta and the pulmonary trunk. In a minority of cases, the left main travels anterior to the pulmonary trunk, posterior to the aorta, or posterior to the right ventricular outflow tract within the ventricular septum.

The third anomaly that may cause sudden cardiac death in the young is ectopic origin of the right coronary from the left sinus of Valsalva. The ostium supplying the right coronary artery may have similar features as anomalous left ostia located in the right sinus. Namely, there may be upward displacement, location near the commissure, and slit-like ostia with ostial ridges. Most deaths are exertional, and occur between the ages of 20 and 35. The majority of patients with this anomaly live a normal life span, but up to 1 in 3 die suddenly.

Coronary artery dissection accounts for approximately 0.5% of sudden deaths in patients 20-40 years old. Most patients are young women, sometimes in the postpartum period, and one patient with Marfan syndrome has been reported. In cases studied clinically, patients have presented with chest pain, electrocardiographic evidence of acute myocardial infarctions, and contrast dye within the false lumen at catheterization. Over 90% of cases causing sudden death involve the left anterior descending coronary artery. Histologically, the dissection plane is in the outer media with infiltrates of eosinophils, lymphocytes, neutrophils and macrophages in the adventitia. The etiology is obscure; although an intimal tear and medial perforation can be found if extensively sought after, clear-cut histologic features of medial dysplasia are usually absent. In about 50% of cases, an acute and/or healed infarction in the area perfused by the dissected artery is seen, generally in the anterior wall of the left ventricle.
Coronary atherosclerosis in patients younger than 40 generally occurs after age 20. Autopsy studies show that, in comparison to patients with severe coronary atherosclerosis dying after age 40 years, there are few lipid-rich plaques, and most thrombi are erosions with ongoing organization of thrombus. Rare causes of sudden coronary death that may occur in the young include coronary vasculitis, coronary thrombosis secondary to coagulopathies, coronary artery dysplasia, and coronary embolism. Coronary vasculitis comprises Kawasaki disease in children < 6 years, isolated (idiopathic) coronary arteritis, and coronary arteritis associated with ascending aortitis (Takayasu disease).

BULLET POINTS:
- Coronary disease is a rare cause of sudden cardiac death under the age of 40 years. The underlying etiology is ectopic origin of the coronary arteries.
- The three most common forms of anomalous coronary artery that causes sudden death are, in ascending order of mean age at presentation, ectopic origin of the left main in the pulmonary trunk, ectopic origin the left main in the right sinus of Valsalva, and ectopic origin of the right coronary in the left sinus of Valsalva.
- Spontaneous coronary artery dissection is the third most common cause of sudden coronary death, after coronary atherosclerosis and anomalous origin, in individuals aged 20-40 years. The etiology is unknown.
- Rare causes of sudden coronary death in the young included coronary arteritis, dysplasia, embolization, and idiopathic thrombosis.
- Coronary atherosclerosis in the young may cause sudden cardiac death and differs from typical atherosclerosis is paucity of lipid rich plaques and frequency of acute plaque erosions.

REFERENCES:

