



Editorial

Coronary artery anomaly and sudden death—Especially focus on anomalous left coronary artery arising from the right sinus

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In this editorial, focus is on the congenital coronary artery anomaly and sudden death, because there are a lot of papers on cardiomyopathy and sudden death in athletes.

Incidence of coronary artery anomaly and sudden death in the general population

Kitada et al. [1] surveyed sudden death in the young in Osaka prefecture and reported that 2/29 suddenly died due to myocardial infarction. However, the cause of infarction in these students was not mentioned. Itoh analyzed the cause of sudden death in 536 school children in Japan and in 209 (39%) of them background heart disease was identified [2]. In more than 80% of 536 sudden death cases, mode of death was related to moderate-to-severe exercise. Coronary artery disease is the 7th most common cause of death (3% of total sudden deaths) [2]. In the series of sudden death cases reported from Toronto General Hospital in Canada, about 25% of 197 deaths in adult congenital heart disease (ACHD) were sudden death [3]. However, the number of patients with congenital coronary artery anomaly is small, because most of these patients were not diagnosed before near-miss sudden death during competitive sports or post-mortem as reported in this case report [4].

Therefore, in spite of their clinical importance, congenital coronary artery anomalies are often neglected topics in cardiology.

According to the literature, coronary anomalies affect 1% of the general population [5]. Although cardiologists have been aware that some coronary anomalies can be fatal (typically in young “healthy” athletes), the exact reasons for sudden death and frequency of it are still unclear. Sudden death is often the only and first symptom of coronary anomalies. In pathological studies [6], regarding patients with anomalous left coronary artery arising from

the right sinus, 59% of them died before the age of 20 years, mainly during or shortly after vigorous exercise. It was reported [7] that coronary anomalies cause 11.8% of deaths in US high school and college athletes and emphasized that the number should not be neglected. According to the American Heart Association report [8], coronary anomalies cause 19% of deaths in athletes. However, in another study [9], only 1 coronary anomaly was found in 162 sudden deaths in a young general population. This number is similar to Japanese data [1,2]. Of note, coronary anomalies can be fatal during or shortly after strenuous exercise, especially in young athletes [9–11]. Angelini and coworkers [10] who performed angiography in 1950 consecutive patients to evaluate coronary artery disease and found a 5.6% incidence of coronary anomalies. These data suggest that around 1/20 of US citizens have some type of coronary anomaly. If 19% of sudden deaths in young athletes are related to these anomalies [12], they should have a strategy for screening, prevention, and management.

Manifestations and sudden death in patients with coronary artery anomaly

Coronary anomalies induce chest pain, syncope, dyspnea, ventricular arrhythmias, myocardial infarction, and sudden death [10]. However, effort angina is reported to be a rare symptom. From the reported cases, left coronary artery from the right sinus is consistently related to sudden death (59% of cases), which follows exercise in 81% of events [12].

Cause of sudden death

Because the coronary arteries primarily supply oxygen and metabolic support to related cardiac myocardium, reduced coronary flow can be the main cause of deterioration of pump function and organ survival. Ischemia due to congenital coronary anomalies can be reproducible with stress testing, or in some cases, ischemia occurs only under extreme clinical conditions [6,12,13]. There are cases with a fibrous ridge at the ostium, which is found in ectopic coronary arteries [14]. Such ridges are often said to induce sudden death [14]. During vigorous exercise, left coronary artery from right aortic sinus with the route between pulmonary artery and aorta will become stenotic by compression of great arteries and possibly induce ischemia.

Report from Italy on congenital coronary artery anomalies with origin from the different aortic sinus

Because some areas of Italy have established screening systems for young people who intend to join athletic clubs, there are several important reports on sudden death in athletes by Italian authors. Basso et al. [15] reported 27 sudden deaths during intense exertion or immediately after that in young athletes, and identified left main coronary artery from the right aortic sinus ($n = 23$) or right coronary artery from the left sinus ($n = 4$). A total of 15 (55%) had no cardiovascular manifestations. The remaining 12 (45%) had premonitory symptoms including syncope or chest pain. All cardiovascular tests [electrocardiography (ECG), stress ECG, and echocardiography] were within normal limits. They concluded that standard testing is not useful as a screening test in large athletic populations, and a history of syncope during exertion or chest pain requires exclusion of this anomaly.

Proper screening test for detection of congenital coronary artery anomaly

Clinically, angiographic documentation of abnormal coronary anatomy has not led to any effective or widely agreed recommendations for functional testing and that finding itself is not indication for treatment for congenital coronary anomalies [6,13]. Exercise tests, intended to reproduce symptoms or to induce changes in electrocardiographic or nuclear-imaging parameters, often produce false-negative or confusing results [10,13]. Reduced coronary functional reserve or abnormal flow patterns during Doppler testing might characterize certain anomalies, but, these are usually inadequate for implicating a specific pathophysiological mechanism of critical ischemia [11].

Current concept on left coronary artery abnormality from right aortic sinus and sudden death

Following hypertrophic cardiomyopathy, coronary artery originating from the different aortic sinuses is the second most common cause of sudden death in athletes in many countries. Although the right coronary can arise from left aortic sinus, and vice versa as the left coronary artery arising from the right aortic sinus, the latter type of anomaly is a more common cause of sudden death with strenuous exercise. Of the left coronary artery arising from the right aortic sinus, especially the interarterial type, where the left coronary artery passes anteriorly between the aorta and the right ventricular outflow tract, is the type in which the patient is at risk of sudden death. Sudden death usually occurs associated with or shortly after vigorous exercise and is unusual after the patient is more than 35 years of age. The mechanism by which there is sudden occlusion of the interarterial coronary artery is unknown, although there are a number of hypotheses involving the oblique passage of the vessel as it leaves the aorta. Sudden death may probably be rare among the people who have these anomalies, many of them supposed to have this anomaly without overt symptoms. Symptoms predisposing a fatal event such as exertional syncope, chest pain, or palpitations are probably common in patients at risk as mentioned above, and surgical correction is indicated in symptomatic patients at any age especially in the younger age group. In older asymptomatic patients, surgery is not recommended, since the incidence of sudden death in this age group is small. In asymptomatic young patients, a moderate grade stress test, preferably with radioisotope myocardial perfusion imaging or stress echocardiogram, may be helpful and surgical correction performed in those with ischemia observed. Since there is evidence that in patients who have survived a potentially fatal event, it is rare to be able to provoke ischemia

with equal or greater exercise, the decision for surgical correction in an asymptomatic young patient, found to have this anomaly, who has a negative exercise test, is controversial.

Conclusions and the future—what we should do to improve detection, diagnosis, and better management

Our knowledge about the clinical expression of anomalous left coronary artery arising from the right sinus is not enough for making accurate diagnosis, establishing proper screening methods for possibility of sudden death, and indications for surgery. For better understanding of this latent but fearful disorder and prevention of sudden death, we need retrospectively and prospectively to collect precise information and basic data in a multicenter database as follows: (1) incidence of the anomaly; (2) manifestations of the anomaly; (3) clinical history of each patient who experiences a clinical event with documentation of the event and the relevant clinical circumstances; and (4) the treatment (exercise limitation, medical, or surgical). The total number of young athletes with anomalous left coronary artery arising from the right sinus is unknown and what percentage of the athletes with this anomaly has a risk for sudden deaths is also unknown. However, it is sure that some patients with this anomaly can suddenly die during exercise, therefore, it is necessary to establish guidelines for screening methods and proper management including aggressive intervention. This congenital coronary anomaly is rarely identified during school-life because of insufficient clinical suspicion. However, since anomalous coronary artery origin possibly requires surgery, timely identification is mandatory.

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