Newer Concepts Regarding Adults with Coronary Artery Aneurysms: Are They All Kawasaki? Does It Make a Difference?

Running title: Angelini et al.; Coronary artery aneurysms and Kawasaki disease

Paolo Angelini, MD and Jorge Monge, MD

Center for Coronary Artery Anomalies, Texas Heart Institute, Houston, TX

Address for Correspondence:
Paolo Angelini, MD
The Center for Coronary Artery Anomalies
Texas Heart Institute
2130 West Holcombe Suite 920
Houston, TX 77030
Tel: 713-790-9401
Fax: 713-790-9401
E-mail: pangelini@texasheart.org

Journal Subject Code: [29] Coronary imaging: angiography/ultrasound/Doppler/CC

Key words: coronary aneurysm; coronary angiography; coronary artery disease; Editorials; Kawasaki disease

Abbreviations: KD: Kawasaki disease; CA: Coronary aneurysm(s)
The most commonly accepted definition of coronary aneurysm (CA) is an enlargement of a coronary arterial segment to more than 50% of the distal reference diameter. This definition generally refers to the inner diameters of the vessels as determined by coronary angiography. Computerized axial tomographic (CAT) imaging is currently the preferred method of studying CA, especially for longitudinal studies of the extent and severity of dilatation, calcification, mural thrombosis, and stenosis. Only tomographic imaging can quantitatively describe vascular wall thickening, a hallmark of the disease progression and prognosis in a post-arteritis CA.

Additionally, the 50% definition can be inaccurate: in cases with diffuse dilatation, the reference diameter can become difficult to identify. The 50% rule may or may not carry prognostic value, which is the main clinical goal of classifying a coronary segment as ectasic or anomalous. The essential clinical interest is in differentiating a CA from the Glagov phenomenon, the mild dilatation of the outer diameter of a coronary artery seen in early atherosclerotic degenerative disease. According to the Glagov theory, the outer diameter of the coronary arteries dilates in the early phases of atherosclerosis, when plaque deposition leads to positive remodeling with preservation of the vessel lumen. Such positive remodeling probably does not allow for a dilatation of the coronary artery greater than 50% of the previous normal diameter.

Studies of coronary flow velocity, by flow- or Doppler-wires, interrogating the full cross-sectional aneurysmatic area of a given CA, would give the most accurate diagnosis of a CA’s severity. Coronary flow velocity studies would be most capable of generating the precise indication of the degree of dilatation based on the principle that blood flow velocity indices at dilated arterial segments (more at the periphery than at the center) are inversely related to segmental dilatation size. Normal coronary size and blood flow velocity are related the size of the
dependent myocardial territory and its metabolic needs during rest and exercise.

The current article by Daniels and colleagues implies such methodological difficulties in identifying Kawasaki disease-related CA, as suggested by the fact that the study includes only adult patients who are less than 40 years old (older patients would have a higher probability of atherosclerotic dilatation, presumably); indeed, the great majority of suspected cases of Kawasaki disease (KD) in this article had aneurysmal diameters more than 100% larger than the reference diameter (hence, larger than is justifiable by the Glagov phenomenon). Unfortunately, the reference diameters were not reported. Coronary aneurysms are frequently encountered during acute KD (about 50% of cases) and years after acute KD (when the incidence of CA is about 25% in untreated KD and 5% in KD treated with gamma globulins). Coronary aneurysm constitutes a fundamental hallmark for the clinical diagnosis of prior KD arteriopathy. In Figures 1 and 2, angiographic and intravascular ultrasound (IVUS) imaging show an example of this pathology, featuring typical absence of significant intimal atherosclerotic thickening in the coronary segments proximal and distal to the aneurysms, as apparent in this 35 year old patient, who had KD when she was 5 years of age. Also shown is evidence of peri-vascular fibrosis, but no calcifications outside the CA (Figure 2). Given the persistent limitations in the reliability of clinical and arteriographic diagnosis of KD, the important question is whether such a diagnosis must be established in an adult with CA or whether a CA’s size alone is an adequate criterion for determining a prognosis and identifying the ideal treatment in a given patient. The only circumstance in which an etiologic diagnosis could be clinically valuable would be if it were important to detect or treat residual inflammatory activity. However, neither a long-term, infection-based cause nor evidence of a persistent, long-term inflammatory state has been validated in adult patients.
Recently, experimental animal models of an arteritis similar to KD have been developed, and they suggest the possibility that KD is not a specific entity but rather the result of a systemic, yet primarily coronary, arteritis that originates in response to different environmental insults, modulated on the basis of variable genetic backgrounds, and eventually leading to a wide spectrum of clinical presentations. This is also supported by the preliminary finding that, in mice-based experimental arteritis, gamma globulin also has a protective effect against the development of CA, as in clinical KD. Recent mechanistic studies suggest that the initial inflammatory reaction in KD is mediated by the early invasion of the intima and media by granulocytes and T cells in the presence of systemic leukocytosis. During the early inflammatory stage, lymphocytes, plasma cells, and macrophages invade the arterial wall, expressing cytokines like TGF, PDGF-A, bFGF, TNF-alpha, and VEGF. In particular, the experimental model of arteritis in mice has been shown to be accompanied by T cell activation, TNF production, and matrix metalloproteinase-9 expression in the arterial wall at the early phase of activity. Such intense inflammatory response is generally absent in the chronic phase of KD in adults.

The prognosis of a CA in adults is related to demonstrable features in any given case: the CA’s location (prognosis is usually worse when the CA is proximal) the CA’s size (CA of more than 8 mm in diameter are associated with a worse prognosis, as Daniels and colleagues write), whether the CA is expanding, the presence of mural thrombosis, and a history of distal coronary embolism. A discussion of differential etiologic diagnosis could be aimed at ruling out either “other” kinds of arteriopathies (those with similarly unclear etiologies), like Behçet’s disease and Takayasu arteritis, or other conditions that could be persistently active, such as autoimmune diseases, or inactive, such as post-traumatic (including surgical) cases. All are treated like CA in KD unless
indices of inflammatory activity are present.

In KD, CAs in adults are generally biologically stable in that there is no inflammatory activity, even though they are subject to progressive calcifications located at the media/intimial interface or the sub-endothelial surface. The prognosis is largely determined by the increased tendency toward mural thrombosis and embolization, which is implied by coronary dilatation and its consequent “slow runoff,” especially in the presence of a damaged endothelial/intimal lining. The risk of coronary external wall rupture is remote and limited to cases with CA diameters greater than 20 mm or that grow with time.

As Gordon and colleagues state in their recent review of KD, “treatment regimens should be tailored based on the size of the aneurysm,” and complementary treatment options in adult patients include antithrombic medication and platelets aggregation inhibitors therapy, surgery, and angioplasty. Interestingly, Kawasaki-related CA (K-CA) apparently does not cause an increased incidence of lipid deposition in young adults with KD (Figures 1-2 show IVUS imaging in the case 30 years after acute KD), but no prospective studies of significant size have been done in older patients, which is currently becoming a growing population. The finding of intense, peri-vascular fibrosis on IVUS could be considered to suggest a protective effect, possibly mediated by the induced absence of peri-arterial fat deposits implied by the observed absence of even the mild atherosclerotic intimal thickening that would be expected for a patient this age.

The potential for KD to develop coronary stenoses associated with CAs apparently has 2 main causes: first, the proliferative mechanism intrinsic to the acute KD process, which causes vascular media-originated smooth muscle cells to proliferate and migrate from the damaged media into the intimal layer, producing large amounts of extracellular matrix and forming a hard fibrotic scar; and second, mural thrombosis/embolism.
Often difficult to diagnose, local coronary embolism can cause chest pain and acute myocardial infarction in patients with K-CA. Magnetic resonance imaging with a scar protocol is the most precise method currently available to identify necrotic damage from local coronary embolisms.

Coronary aneurysms may be progressive in size for a few different reasons. The original disruption of the media, which is the strongest structure in the arterial wall, is the main causative factor. In theory, it is possible that exercise habits could contribute to a CA’s expansion, especially in younger patients. Heavy weightlifting in particular should probably be avoided because of the sudden increase in intravascular pressure and strain that accompany it. Hypertension and trauma by sudden deceleration could also be contributing factors.

Research on the development of Kawasaki-related CA should focus on prospective studies of pediatric patients known to have had KD rather than prevalence studies of general adult populations; such studies would lack clear inclusion criteria. The pretest likelihood of KD and CA should be known (reasons for study), and the diagnostic methods (autopsy, CAT scan, or coronary angiography) to be used should be selected, with the intention to obtain interpretable information.

In conclusion, ascertainment of a past history of KD as the etiology of CA in the adult is frequently difficult and only marginally helpful in planning optimal therapy; rather, treatment should be based on CA architecture and pathophysiology. In contrast, in children, the diagnosis of acute KD is essential to establish prevalence data and, most importantly, to institute early treatment with intravenous gamma globulin to prevent aneurysm formation.

**Conflict of Interest Disclosures:** None
References:


Figure Legends:

Figure 1. Catheter coronary angiography still frames in a 35-year-old patient with Kawasaki-proven aneurysms. In Figure 1A, the right coronary artery is free of significant angiographic disease, whereas the localized heavy calcifications in the left coronary arteries are typical of coronary Kawasaki-related aneurysms. During coronary angiography, such calcifications (located on the outer arterial wall) allow for the measurement of the outer diameters of the left coronary aneurysms (A), whereas mural thrombosis can be assessed (as indicated by the space between the angiographic lumen in A and the outer calcifications in B). Measurements of inner and outer diameters are provided in mm. Notice the relatively normal lumens at the patent branches distal to the aneurysms, while the circumflex (asterisk) and the diagonal branches were chronically occluded at their origins from the aneurysmatic proximal segments.

Figure 2. (A) Intravascular ultrasounds imaging of the left main ostium. Note the absence of intimal thickening and the presence of extensive perivascular fibrosis in the absence of aneurysm (just proximal to large aneurysm of the same vessel). Space markings are in mm. (B) Intravascular ultrasound imaging of the LAD, distal to the aneurysm. Note the absence of intimal thickening and of calcium deposits. Moderate amount of perivascular fibrosis is present.
Newer Concepts Regarding Adults with Coronary Artery Aneurysms: Are They All Kawasaki?
Does It Make a Difference?
Paolo Angelini and Jorge Monge

Circulation. published online May 17, 2012;
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2012 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circ.ahajournals.org/content/early/2012/05/15/CIRCULATIONAHA.112.106880

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in
Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office.
Once the online version of the published article for which permission is being requested is located, click Request
Permissions in the middle column of the Web page under Services. Further information about this process is
available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org/subscriptions/