

# iCONCEPTS

CONCEPTS ON THE VERGE OF TRANSLATION

## Great Vessel and Coronary Artery Anatomy in Transposition and Other Coronary Anomalies

### A Universal Descriptive and Alphanumerical Sequential Classification

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In patients with transposition of the great arteries, the identification of coronary anatomy is fundamental to optimal surgical outcome. A number of classifications describing the coronary vessels' origin and course in transposition of the great arteries have been published. However, all are limited to operative or pathological case series. They are often alphanumeric classifications that do not lend themselves to clinical practice; they do not consider certain important anatomical variations that may increase surgical morbidity and mortality, nor do they fully delineate coronary anatomy or define the relationship to adjacent structures seen with cardiovascular computed tomography. Using cardiovascular computed tomography for illustrative purposes, we propose and validate a universal sequential descriptive classification and an associated alphanumeric classification that may be used for all coronary anomalies with or without associated congenital heart disease. (J Am Coll Cardiol Img 2013;6:624–30) © 2013 by the American College of Cardiology Foundation

Coronary computed tomography (CT) angiography allows for a complete visualization of the origin and course of the coronary arteries, in context with the surrounding cardiovascular anatomy. Although of great potential for the analysis of anomalous coronary anatomy, this leads to the requirement of a comprehensive descriptive framework for the coronary arteries and great vessels to allow cardiologists, radiologists, and surgeons alike to accurately describe and classify coronary and cardiovascular anatomy. Existing alphanumeric classifications of coronary anatomy, though useful in the research and taxonomy settings are of limited value within clinical settings where they do not cover all

coronary variants and where their use requires a complete understanding of the alphanumeric code by all clinicians. Whereas a sequential descriptive classification exists for atrioventricular and ventriculo-arterial connections, there is currently a lack of a universal, systematic descriptive classification for coronary and great vessel anatomy.

Clinically, coronary anomalies matter. In patients with transposition of the great arteries (TGA), the identification of coronary anatomy is fundamental to optimal surgical outcome (1). At the more benign end of the spectrum this may include 3 separate coronary ostia (Fig. 1), whereas a single coronary ostium (Fig. 2)

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confers a 3-fold mortality increase, a “malignant” intramural/interarterial coronary artery (Fig. 3) is associated with 6-fold increase in mortality, whereas overall mortality in those patients with abnormal anatomy is nearly double (1). (We use “malignant course” to describe both interarterial [major epicardial vessel running between the right ventricular outflow tract and the aortic root] and intramural [coronary arteries additionally reside within the aortic wall for a variable duration of their interarterial course]. The use of multidetector CT to differentiate between these 2 types of malignant courses is both unproven and challenging; however, both are associated with poorer prognosis.) As a result of the association of coronary anomalies with adverse outcomes in TGA, the classification of coronary anatomy in TGA has been attempted by several investigators (Table 1). However, all previous classifications are incomplete as they are based on relatively small surgical, pathological, or echocardiographic series and, therefore, are limited to these case series and cannot be applied to other anomalies. No previous classification comprehensively covers important anatomical variations that have been demonstrated to, or have the potential to, increase surgical morbidity and mortality. Finally, they cannot be used to describe isolated coronary anomalies that may predispose to sudden cardiac death.

Partial classifications do exist for certain coronary anomalies (such as Lipton’s classification of isolated single coronary artery patterns and Angelini’s proposed descriptive approach to coronary anatomy at angiography [2]), but again these are limited, for example, to invasive angiography and only applicable to patients without congenital heart disease (CHD). Additionally, they are not transferable for use with other imaging modalities.

Clinically, Leiden’s classification is often used. However, this alphanumeric classification is complicated and may not fully describe coronary anatomy, and the codex needs to be understood by all clinicians to be of practical use. The description of the aortic sinuses within the Leiden classification is also confusing (Fig. 4), and the relationship between the aortic root and pulmonary artery is not routinely described. The Leiden classification cannot be used to describe the anatomy in congenitally corrected transposition of the great arteries (ccTGA) where the “normal” variation of the coronary anatomy also influences both natural history and prognosis nor

in isolated coronary anomalies that are increasingly recognized in patients.

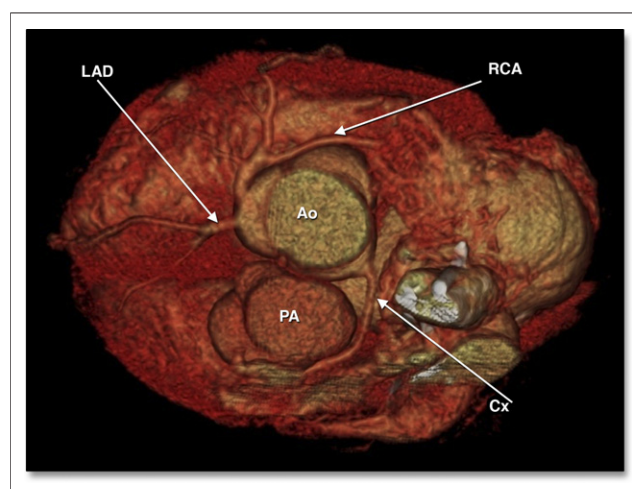
We propose both a universal, descriptive, sequential approach for use clinically and an alphanumeric equivalent for the purposes of taxonomy and research where a shorthand description allows for a simple, universal, and standardized codex. Both classifications allow for the complete delineation of great vessel and coronary anatomy, comprehensively encompassing variations with significant morbidity and mortality.

**Sequential descriptive and alphanumeric classification of coronary anatomy.** For the clinical setting, we developed a descriptive approach to delineate the great vessel and coronary anatomy. However, we also believed there was a value in an alphanumeric system for taxonomy and research, and we recognized the potential to break down the descriptive classification into an alphanumeric classification. Therefore, we also present our descriptive classification as an extended Leiden alphanumeric classification that can be used in all CHD patients and isolated coronary anomalies based on multidetector CT.

We describe the relationship of the aorta (Ao) to the pulmonary artery (PA) and then the coronary anatomy. In both classifications, we allow for additional ostia to be described, describe which arteries supply which ventricles in ccTGA, and, if

#### ABBREVIATIONS AND ACRONYMS

- Ao** = aorta
- ccTGA** = congenitally corrected transposition of the great arteries
- CHD** = congenital heart disease
- CT** = computed tomography
- PA** = pulmonary artery
- TGA** = transposition of the great arteries



**Figure 1. VR Image Shows Coronary Vessels From 3 Separate Coronary Ostia**

Ao = aorta; Cx = circumflex artery; LAD = left anterior descending artery; PA = pulmonary artery; RCA = right coronary artery; VR = volume rendered.

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