Clinical Imaging 39 (2015) 938–944

Contents lists available at ScienceDirect

Clinical Imaging

journal homepage: http://www.clinicalimaging.org

3D MDCT angiography for the preoperative assessment of truncus arteriosus

Sun Hwa Hong [a], Yang Min Kim [a,*], Chang-Keun Lee [a], Chang-Ha Lee [b], Seong Ho Kim [c], Sang Yun Lee [c]

[a] Depargment of Radiology, Sejong General Hospital, Bucheon, Gyeonggi, Republic of Korea
[b] Department of Thoracic Cardiovascular Surgery, Sejong General Hospital, Bucheon, Gyeonggi, Republic of Korea
[c] Department of Pediatrics, Sejong General Hospital, Bucheon, Gyeonggi, Republic of Korea

ARTICLE INFO

Article history:
Received 11 March 2015
Received in revised form 7 July 2015
Accepted 8 July 2015

Keywords:
Truncus arteriosus
Congenital heart disease
Multidetector computed tomography
3-Dimensional rendering

ABSTRACT

Truncus arteriosus is an uncommon conotruncal anomaly, which is amenable to surgical correction. The systemic, pulmonary, and coronary circulations originate from a single arterial vessel that arises from the ventricular part of the heart and overrides the ventricular septum. The value of multidetector computed tomography with three-dimensional postprocessing lies in the detailed assessment of the presence or absence of the pulmonary arteries, including the number, origin, and branching patterns of major aortopulmonary collateral arteries, and extracardiac abnormalities such as aortic arch interruption. This article reviews the various imaging spectra of truncus arteriosus, which are especially important in the surgical planning.

1. Introduction

Persistent truncus arteriosus is a relatively uncommon conotruncal anomaly, and it accounts for approximately 1–4% of all congenital cardiac malformations. It occurs as a result of the failure of the conotruncal septation, during fetal development, and is related to both the chromosome 22q11 deletion and DiGeorge syndrome. It is characterized by a single arterial trunk that originates from the ventricular part of the heart, overrides the ventricular septum, and supplies branches to the systemic, pulmonary, and coronary circulations [1]. The truncal valve is often dysplastic, with thickened cusps and supernumerary leaflets, usually with two to five cusps that are usually either stenotic or regurgitant. An interrupted aortic arch is a commonly associated lesion (11%–14% of patients) and is usually situated between the left carotid and subclavian arteries [2,3]. A ventricular septal defect (VSD) is present in almost all of the patients just below the common arterial trunk due to absence of the right ventricular infundibular septum.

The coronary arteries stem from the sinuses of Valsalva. The left and right coronary arteries often originate from the left posterior cusp and right anterior cusp, respectively [4]. Other cardiac anomalies include secundum atrial septal defect, right aortic arch, aberrant subclavian artery persistent left superior vena cava, and tricuspid stenosis.

An exact preoperative diagnosis is very important because the optimal timing and procedure for truncus arteriosus repair are decided on the basis of the morphological characteristics. The presence of interruption of the aortic arch is one of the factors that influence the outcome and mortality [5,6].

The purpose of this pictorial review is to illustrate multidetector computed tomography (MDCT) angiography imaging, with three-dimensional (3D) postprocessing to evaluate the preoperative anatomic features of truncus arteriosus.

2. Classification

Historically, there are two major classification systems for truncus arteriosus: that by Collett and Edwards and that by Van Praagh and Van Praagh [7,2]. The Collett and Edwards classification is based on the origin of the pulmonary arteries. In the Collett–Edwards system, Type 1 is characterized by a single pulmonary artery (PA) trunk arising from the proximal left lateral aspect of the common trunk. This is the most common type (48–68% of cases). Type 2 is characterized by the absence of the pulmonary trunk and separate origin of the pulmonary arteries from the posterior aspect of the truncus (29–48% of cases). Type 3 is characterized by the absence of the pulmonary trunk and separate origin of the pulmonary arteries from the lateral aspect of the truncus (6–10% of cases). Type 4 is characterized by pulmonary arteries arising from the descending aorta (DAo) and is currently considered as a form of pulmonary atresia with a VSD (also termed *pseudotruncus*).

The classification system by Van Praagh and Van Praagh considers the roles of the patent ductus arteriosus (PDA) and the interrupted

* Corresponding author. Department of Radiology, Sejong General Hospital, 28, 489 gil, Hohyeon-ro, Sosa-gu, Bucheon-si, Gyeonggi-do, 422–711, South Korea. Tel.: +82-32-340-1188; fax: +82-32-340-1180.
E-mail address: jesuscare00@naver.com (Y.M. Kim).

http://dx.doi.org/10.1016/j.clinimag.2015.07.019
0899-7071/

aortic arch, which are associated anomalies that have prognostic and surgical implications. This classification further divides into Type A (the presence of a VSD) and Type B (the absence of a VSD). In the Van Praagh system, Type 1 truncus arteriosus is identical to Collett and Edwards' Type 1. Type 2 truncus arteriosus corresponds to Collett and Edwards' Types 2 and 3. Type 3 represents atresia of the left or right PA, with pulmonary blood supply to the other lung provided either by a PA arising from the aortic arch or by systemic to pulmonary arterial collaterals (a variant of Collette and Edwards' Type 2). Type A4 is characterized by the presence of an associated interrupted aortic arch in addition to Types 1 and 2 (Fig. 1). Type 4 has no similar type in the Collett and Edwards classification.

3. Surgical repair

The surgical repair of truncus arteriosus was first developed approximately 30 years ago, and now most patients undergo correction within the first few weeks after birth. Surgical repair of truncus arteriosus includes VSD patch closure and detachment of the pulmonary arteries from the arterial trunk with formation of a right ventricle to PA conduit. The truncal valve may also require repair, and aortic arch interruption or coarctation is repaired at the same time. Lifelong surveillance is required, and multiple interventions may be needed because of the nongrowing homograft [8].

4. MDCT findings

In children with congenital heart disease, MDCT angiography has been increasingly used [9–11]. Echocardiography is almost always the primary imaging modality for patients with truncus arteriosus, but it is an operator-dependent imaging modality and is also inadequate for the visualization of extracardiac structures [12]. It has limited ability in the evaluation of anomalous vessel anatomy, origin, and branching of the arterial trunk. MRI also has several disadvantages compared with computed tomography (CT), including poor spatial resolution, breathing and motion artifacts, metal artifacts, need for general anesthesia, and longer imaging time. MDCT provides excellent anatomical evaluation of truncus arteriosus [13]. MDCT angiography is a noninvasive method that provides very high-resolution 3D images of the anatomical morphology and can easily demonstrate the number, origin, and branching patterns of major aortopulmonary collateral arteries (MAPCAs), abnormal origin and branching of the arterial trunk, as well as cardiac and extracardiac abnormalities such as aortic arches, coronary artery abnormalities, and aberrant subclavian arteries [14,15].

Radiation exposure from a CT scan is a major concern in pediatric patients. However, recent technical innovations such as wider detectors, shorter gantry rotation times, increased table speed or pitch, and tube current modulation have been used to reduce radiation doses while maintaining an acceptable diagnostic image quality [16–18].

In Collett–Edwards' Type 1 and Van Praagh's Type A-1 truncus arteriosus, MDCT shows the solitary arterial trunk overriding a VSD and branching into a right-sided ascending aorta and left lateral-sided short pulmonary trunk. The short pulmonary trunk then divides into right and left pulmonary arteries (Fig. 2). In Collett–Edwards' Type 2 and Van Praagh's Type A-2 truncus arteriosus, MDCT shows the absence of the pulmonary trunk and the origin of the separate right and left pulmonary arterial branches directly from the common arterial trunk. The proximity of the origin of the pulmonary arteries is also demonstrated (Fig. 3).

In Van Praagh's Type A-3 truncus arteriosus, MDCT visualizes the absence of the left or right PA, with collateral flow to the ipsilateral lung. Preoperative CT 3D volume-rendered imaging clearly demonstrates the origin of one PA from the common trunk, with the other PA being connected by a MAPCA. The number, origin, and branching patterns of MAPCAs may help with surgical planning (Figs. 4, 5).

In Van Praagh's Type A-4 truncus arteriosus, the truncus arteriosus is combined with aortic arch hypoplasia, coarctation, or interruption. Usually a well-formed main PA and a small ascending aorta are present. MDCT is an effective and rapid imaging modality for determining the anatomy of the aortic arch, the degree of stenosis, and visualization of collateral vessels (Fig. 6).

5. Conclusion

MDCT angiography is a good modality for preoperative determination of the anatomical classification of truncus arteriosus. MDCT angiography is also useful for the evaluation of associated cardiovascular anatomic anomalies.

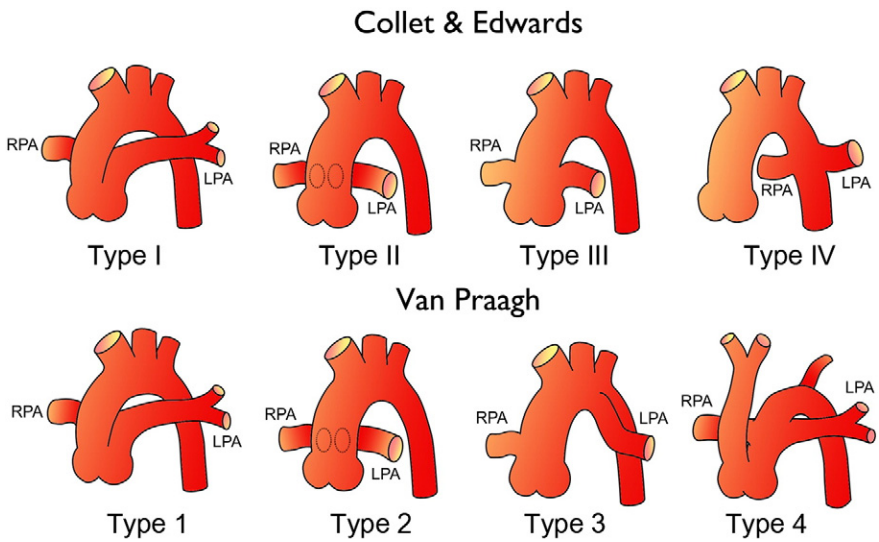

Fig. 1. Diagrams for classifying truncus arteriosus. Top row: Collett–Edwards system. Bottom row: Van Praagh system.