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Original Article

Echocardiography and 64-Multislice Computed Tomography Angiography in Diagnosing Coronary Artery Fistula

*Ping Zhang,[1] Guoxiang Cai,[2] Jianghua Chen,[3] Yiqing Wang,[4] Shaoyin Duan[1,2]**

Background/Purposes: There are various types of coronary artery fistula (CAF) with complex shapes; therefore, it is important to obtain a correct diagnosis and to understand its relations to the adjacent structures before surgery. This study evaluated echocardiography and 64-multislice computed tomography (64-MSCT) angiography in diagnosing CAF.

Methods: Sixteen patients with CAF, confirmed by surgical operation or digital subtraction angiography, were examined by echocardiography. Five of them were further examined by 64-MSCT angiography for detailed anatomical information before surgery. The imaging data for echocardiography and 64-MSCT angiography were analyzed retrospectively.

Results: Among the 16 patients, 12 were correctly diagnosed by echocardiography, of whom five were confirmed by 64-MSCT angiography. Four cases missed diagnosis by echocardiography, and one of these was correctly diagnosed by 64-MSCT. Seventeen fistulae were found, of which, two appeared in one patient. Ten fistulae originated from the left coronary artery and seven from the right. The draining site was the right heart in eight, pulmonary artery in five, left heart in three and aorta in one.

Conclusion: Echocardiography can act as the routine examination of CAF, and 64-MSCT angiography can provide more detailed anatomical and pathological information for surgery than echocardiography.

Key Words: coronary artery fistula, echocardiography, multislice computed tomography

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Coronary artery fistula (CAF), congenital or acquired, is clinically rare. It involves an abnormal and direct vascular communication between a coronary artery (CA) and other cardiac structures, either cardiac chambers or major vessels. Patients with CAF lack clinical symptoms but might suffer from myocardial ischemia or heart malfunction; therefore, early diagnosis is necessary.[1,2] Echocardiography has been used for diagnosis of CAF, yet there are some limitations, such as low resolution of images or effects of lung gases.[3–6] Digital subtraction angiography (DSA) has been accepted as

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[1]Department of Radiology, Teaching Hospital (Zhongshan), Fujian medical University, Departments of [2]Medical Imaging and [3]Ultrasound, and [4]Heart Center, Zhongshan Hospital of Xiamen University, Xiamen, China.

***Correspondence to:** Dr Shaoyin Duan, Department of Radiology, Teaching Hospital (Zhongshan), Fujian medical University, Xiamen 361004, China.
E-mail: xmdsy@xmzsh.com

the gold standard for the diagnosis of CAF; however, it is an invasive and expensive examination. In recent years, with the application of the 64-multislice computed tomography (64-MSCT), DSA is being replaced by computed tomography angiography (CTA). CTA has been extensively used in examining cardiovascular diseases.[7–10] In this study, we retrospectively analyzed and compared the imaging data of echocardiography and 64-MSCT angiography in diagnosing CAF.

Materials and Methods

Study subjects

From May 1, 2005, to March 20, 2010, we enrolled 16 patients with CAF (9 male and 7 female; age range, 2–62 years) that was confirmed by surgical operation or DSA in our hospital. All 16 patients were examined by echocardiography, of whom five were further examined by 64-MSCT angiography.

Equipment

An ultrasound scanner (Acuson Aspen, GE, USA) with a 3.5-MHz transducer was used in 16 cases. For echocardiography examination, conventional and non-standard sections, and color Doppler blood flow were observed. A 64-MSCT scanner (Light Speed VCT, GE, USA) was used in five cases, as well as the Advantage Workstation 4.2, non-ionic contrast medium (Omnipaque 320 mgI/m, GE, Shanghai, China), normal saline and double-tube high-pressure injector (Stellant, Medred Co., USA). Patients were on the supine position with the electrocardiogating control. Scanning parameters included tube voltage 120 kV, tube current 600 mA, collimation 0.625 mm and rotation time 330 milliseconds. Slice thickness was 0.625 mm and pith of 0.2. Three-dimensional (3D) images were obtained with volume rendering (VR), maximum density projection, multiplanar reconstruction and curved shape reform (CPR). The imaging data of echocardiography and 64-MSCT angiography were retrospectively analyzed and data were compared using Fisher's exact test. A p value < 0.05 was considered statistically significant.

Results

Among the 16 patients with CAF, 12 with fistulae between 0.3 cm and 0.6 cm were correctly diagnosed with echocardiography, of whom five were confirmed with 64-MSCT angiography (Figures 1–4). Four patients with fistulae between 0.15 cm and 0.25 cm were missed by echocardiography, of whom one was correctly diagnosed with 64-MSCT angiography (Figure 5), and another was diagnosed with two fistulae. Ten fistulae originated from the left CA and seven from the right CA. Their draining site included the right heart (8 fistulae), pulmonary artery (5 fistulae), left heart (3 fistulae) and aorta (1 fistula) (Table 1).

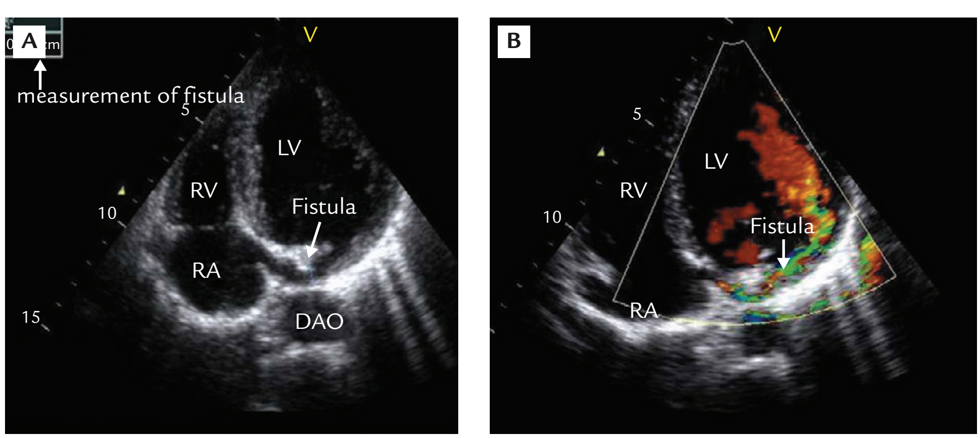

Figure 1. Echocardiography images of atypical long-axis parasternal view show (A) a right coronary artery–left ventricle fistula and (B) aliasing mosaic blood flow (white arrow). DAO = descending aorta; LV = left ventricle; RA = right atrium; RV = right ventricle.

Both echocardiography and 64-MSCT angiography showed the origin of CAF and the size of fistula (Tables 1 and 2). In addition, echocardiography showed the aliasing mosaic blood flow (Figure 1), and 64-MSCT angiography showed the whole shape, course and wall calcification of CAF and the surrounding structures (Figures 2–4).

Of the 16 patients studied, continuous systolic murmurs in the left parasternal region (grades 2–3 of 6) were found in 13 patients, of which, one

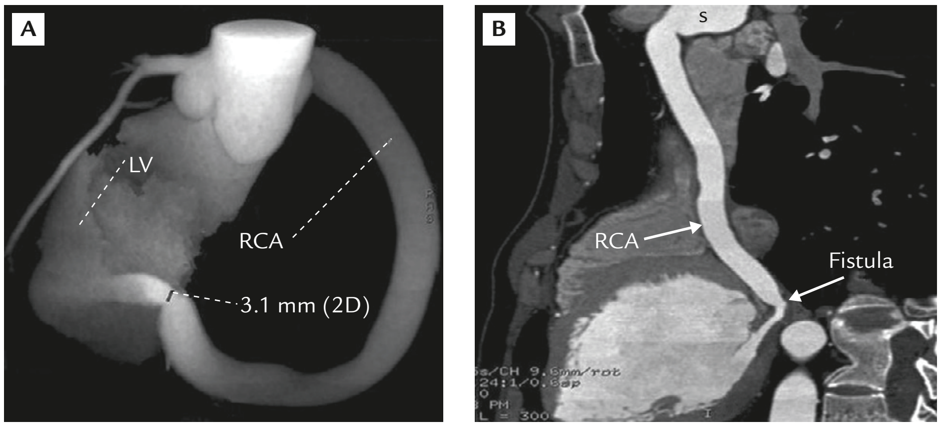

Figure 2. 3D-weighted (A) maximum density projection and (B) curved shape reform images show a right coronary artery–left ventricle fistula (0.31 cm in diameter in A). LV = left ventricle; RCA = right coronary artery.

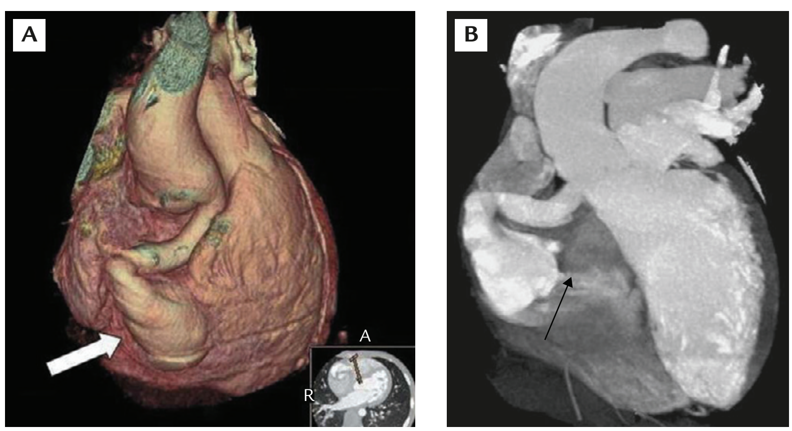

Figure 3. (A) Volume rendering and (B) thin-maximum density projection images show the whole course of the right enlarged coronary artery like a huge lump and the fistula draining into the right ventricle (white arrow and black arrow).

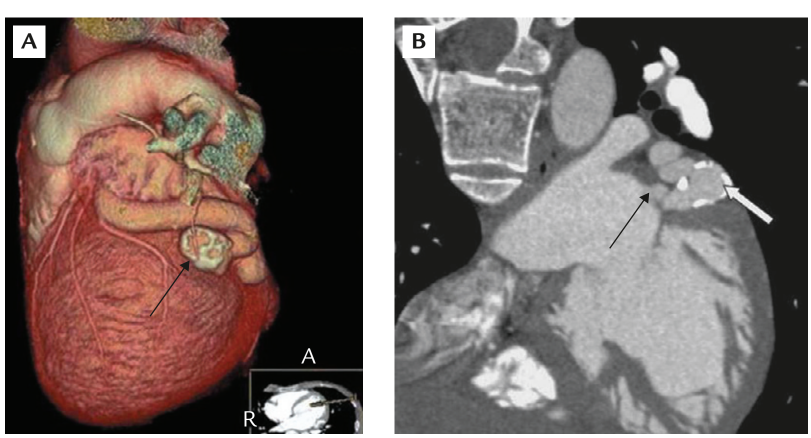

Figure 4. (A) Volume rendering and (B) multiplanar reconstruction images show the left enlarged coronary artery with wall calcification (black arrow in A and white arrow in B) and the fistula draining into the left antrum (black arrow in B).

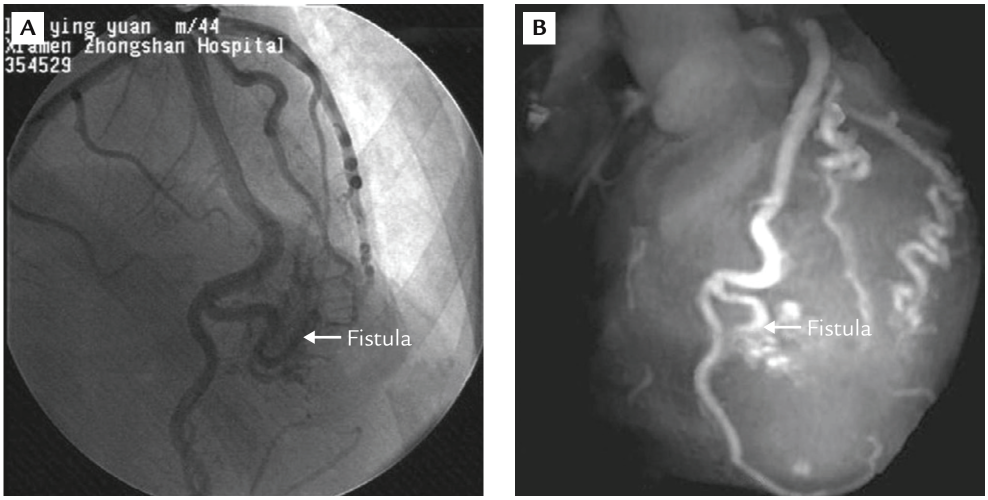

Figure 5. (A) Digital subtraction angiography and (B) 3D-weighted-maximum density projection show a left anterior descending artery left ventricle fistula (white arrow).

Table 1. Diagnosis and treatment of 16 patients with coronary artery fistula and the size of fistula

No.	Sex/age (yr)	Diagnosis	Gold test	Origin/dilation	Draining	Size of fistula (cm)			
						CTA	US	DSA	Surgery
1	M/9	CT & US	Surgery	RCA/[+]	RV	0.42	0.38	–	0.45
2	M/27	CT & US	Surgery	RCA/[+]	LV	0.31	0.47	–	0.30
3	F/15	CT & US	Surgery	LCA/[+]	RA	0.60	–	–	0.60
4	M/29	CT & US	Surgery	LCA/[+]	LA	0.34	–	–	0.35
5	F/43	CT & US	Surgery & DSA	LCA/[+]	LV	0.25	Mis	0.25	0.25
6	F/5	US	Surgery	RCA/[+]	RV	–	–	–	0.30
7	M/2	US	Surgery	RCA/[+]	RV	–	–	–	0.30
8	F/17	US	Surgery	RCA/[+]	RA	–	–	–	0.60
9	F/5	US	Surgery	LCA/[+]	RA	–	–	–	0.40
10	F/10	US	Surgery	LCA/[–]	RV	–	0.56	–	0.30
11	M/3	US	Surgery	LCA/[–]	PA	–	–	–	–
12	M/42	US	Surgery	RCA/[+]	PA	–	–	–	–
13	M/23	US	Surgery & DSA	LCA/[–]	PA	–	0.34	0.20	0.20
14	M/62	US	DSA	LCA/[–]	PA	–	Mis	0.25	–
15	F/33	US	DSA	LCA/[–]	PA	–	Mis	0.20	–
				RCA/[–]	Aorta	–	Mis	0.15	–
16	M/59	US	DSA	LCA/[+]	RV	–	Mis	0.25	–

M = male; F = female; CT = computed tomography; US = ultrasound; DSA = digital subtraction angiography; LA = left atrium; LCA = left coronary artery; LV = left ventricle; Mis = missed diagnosis; PA = pulmonary artery; RA = right atrium; RCA = right coronary artery; RV = right ventricle; – = no measurement.

was accompanied by atrioventricular septal defect, and patent ductus arteriosus, and another two were accompanied by ventricular septal defect. The heart murmurs disappeared after surgical repair. Chest distress and heart failure were found in three cases, of which, two were accompanied by exertional angina pectoris and one by myocarditis, whose diagnoses were confirmed by DSA.

Discussion

Characteristics of CAF

CAF is an abnormal communication from the CA to the cardiac chambers or major vessels. Its originating CA might be dilated, with tortuousity and fusiform dilation or capsular aneurysm. Patients with CAF might occasionally show

Table 2. Comparisons between echocardiography and 64-multislice computed tomography angiography

	Echocardiography	64-MSCT angiography
No. of cases	16	5
Signs		
Fistula	+	+
Course	−	+
Blood flow	+	−
Peripheral constitution	−	+
Diagnosis*		
No. of positive cases	12	5
No. of negative cases	4	0
Gold standard		
DSA	3	0
Surgery	11	5
Surgery & DSA	2	0

**Fisher's exact test, $p = 0.304$. + = full view; − = lack of full view; DSA = digital substraction angiography; 64-MSCT = 64-multislice computed tomography angiography.*

merging of several condition, such as patent ductus arteriosus, malposition of great arteries, and Tetralogy of Fallot. Most patients aged > 20 years have the stealing phenomenon of the CA, which may develop into serious and fatal complications, so they would undergo surgery because the surgical risk is less than that of the complications. In our study, 17 fistulae were found in 16 patients, of whom one had two fistulae. These fistulae were different in size and shape, with some appearing like a net or cluster. Thirteen patients with heart murmurs underwent surgical repair and achieved good outcomes, which is similar to previous studies.[11–14]

Diagnosis values

Echocardiography has a high value in showing the origin of CAF, draining cardiac chamber and hemodynamics changes. However it cannot clearly show small fistula the whole CAF, normal CA or wall calcification.[12,15] In our study, 12 patients with CAF were correctly diagnosed with echocardiography and confirmed by surgery, but four cases with a fistulae smaller than 3 mm were not diagnosed. This implies that echocardiography cannot easily show fistulae that are 3 mm. 64-MSCT correctly diagnosed five patients with CAF, showing the smallest fistula of 2.5 mm, similar to surgery. In addition, 64-MSCT angiography can show wall calcification, and the whole shape or course of CAF and surrounding structures. These results have attracted the attention of the surgeons in our hospital. They think that 64-MSCT is safe, dependable, and accurate in diagnosing CAF, and can yield a lot of information about anatomy and pathology before surgery.[16–19] In our study, we could not say that we found a significant difference between echocardiography and 64-MSCT angiography for diagnosis of CAF because the sample number was limited. A larger sample size would be needed to show a significant difference between them.

Imaging techniques of CTA

64-MSCT angiography is a reliable and noninvasive examination. It helps to identify anomalous CAs and their courses. 3D imaging allows us to demonstrate the size and location of a fistula at any projection without repeated radiation exposure or additional contrast load. Data from 64-MSCT angiography are helpful for future treatment in cardiovascular intervention, and the technique is more advantageous than conventional coronary angiography.[10,11] VR-3D imaging is the most common imaging technique and can show CAF, including the origin, course, dilation of CA and adjacent structures. Maximum density projection-3D imaging can clearly show not only the calcification, narrowing, or dilation of the blood vessel but also the relations between the lesion and adjacent structures just as DSA does. CPR and multiplanar reconstruction are 2D imaging, which can supplement for VR in showing the shape and size of CAF, wall calcification, and lumen structure.[19,20] 64-MSCT angiography is a multi-imaging technique and is better at displaying the normally distributed CA and small abnormal communications with the cardiac chamber or vessels.[21]

Differential diagnosis

CAF must be distinguished from some related diseases, such as the rupture of aortic sinus aneurysm, aorta right ventricle tunnel, or Kawasaki disease. Rupture of aortic sinus aneurysm refers to the intrusion of the enlarged aortic sinus into the cardiac chamber without any CA abnormality. The aorta right ventricle tunnel, going by the aortic valve, is an abnormal communication between the ascending aorta and the left ventricle. Kawasaki disease shows CA dilation, without abnormal blood flow or communication with the cardiac chamber.[15,22,23]

In summary, 64-MSCT angiography can show all the direct signs of CAF, including the origin, fistula and surrounding structures. It provides more information for surgery than echocardiography does, and it has important clinical value for examination of patients who have suspicion of CAF.

Acknowledgments

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