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Echocardiographic diagnosis of sinus of Valsalva aneurysm: A 17-year (1995–2012) experience of 212 surgically treated patients from one single medical center in China

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ABSTRACT

Objective: To evaluate the value of echocardiography in the diagnosis of different pathological patterns of sinus of Valsalva aneurysms (SVAs).
Methods: Echocardiographic features and surgical findings of 212 consecutive patients with SVAs treated in the last 17 years (1995–2012) at the Union Hospital of Huazhong University of Science and Technology were compared and analyzed retrospectively.
Results: 212 Chinese patients with SVAs underwent surgical repairs from January 1995 to May 2012 in our hospital. The aneurysms originated from the right, non-, multiple and left coronary sinus in 77.8%, 19.3%, 2.4% and 0.5%, respectively. 71.7% were ruptured, most commonly into the right ventricle (67.9%) followed by the right atrium (27.4%). Other rare entry sites of rupture included the left atrium, the left ventricle, the interatrial septum, the interventricular septum and the pulmonary artery (0.5%–1.9%). 164 SVAs arising from the right coronary sinus were classified by the Sakakibara method: 47.6% type I, 33.5% type II, 6.1% type IIIv and 12.8% type IIIa. 41 aneurysms of the non-coronary sinus were classified by the Guo method: 61.0% type I, 34.1% type IIa and 4.9% type IIv. The three most common associated cardiovascular lesions were ventricular septal defect (VSD) (53.3%), stenosis of right ventricular outflow tract (RVOTS) (7.5%) and aortic valvular malformations (5.2%).
Compared with surgical results, the sensitivity, specificity and accuracy of echocardiographic diagnosis of SVAs were 93.9%, 99.9% and 99.8%, respectively. Of the 13 SVAs that were missed on echocardiography, 77% were small aneurysms of the right coronary sinus extending into the right ventricle across a VSD. Of the 199 cases diagnosed by echocardiography prior to surgery, the diagnostic accuracy of aneurismal origination, termination and whether ruptured or not was 99.0%, 99.0% and 97.5%, respectively. Echocardiography also diagnosed accurately all of the complications of the SVAs with the exception of aneurismal vegetations. The sensitivity, specificity and accuracy of echocardiography in diagnosing the associated cardiovascular lesions were 89.2%, 99.9% and 99.0%, respectively. The most common misdiagnosis and misdiagnosed associated lesions were the RVOTS and the types of VSD, respectively.
Conclusions: Echocardiography has a specific value in the diagnosis of different pathological patterns of the SVAs with distinguishing ultrasonic features. To the best of our knowledge, this is the largest series of patients with SVAs surgically treated in a single medical center.

1. Introduction

Sinus of Valsalva aneurysm (SVA) is an uncommon but important congenital cardiovascular anomaly, occurring in approximately 1.2% to 1.8% of the Chinese population, which, however, is much commoner than 0.14% to 0.96% of the western populations [1,2]. Echocardiography is currently the most frequently used method of diagnosis. There are

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characteristic diagnostic features in different pathological patterns of the SVA. We compared the echocardiographic features and surgical findings of 212 consecutive Chinese SVA patients in the last 17 years (1995–2012) at the Union Hospital of Huazhong University of Science and Technology, retrospectively, to evaluate the diagnostic value of echocardiography in different patterns of SVA and to discuss how to improve further the diagnostic accuracy based on our experience as well as the literature review.

2. Materials and methods

2.1. Patient population

212 patients with congenital SVA underwent surgical repairs from January 1995 to May 2012 at the Union Hospital, constituting 2.0% of all 10,820 open-heart operations in these years. The ratio of male to female patients was 2:1 (142:70). Age ranged from 1.5 to 60 years old (mean 26.8 ± 12.1 years). Presenting symptoms included dyspnea, easy fatigability, palpitation and chest pain.

2.2. Echocardiography

All patients underwent a complete transthoracic 2-D and Doppler echocardiographic examination using an ultrasound system (GE Vivid 7, Vingmed, Horten, Norway/GE Vivid 7 Dimension, Vingmed, Horten, Norway/Philips IE 33, Andover, MA, USA/Acuson Sequoia C256, Mountain View, CA, USA/HDI 5000, Agilent Technologies, Andover, MA, USA) with a 3- to 7.5-MHz probe.

The key planes included a parasternal long-axis view of the left ventricle, a short-axis view of the aortic root, a long-axis view of the right ventricular outflow tract (RVOT), an apical 5-chamber view and some modified, non-standard views showing the aortic root. In particular, the following details were thoroughly identified on review of the images: size, origin and termination of the SVA; continuity of the aneurismal wall; aneurismal morphological change and movement during each cardiac cycle; severity of any involved valvular insufficiency, especially of the aortic valve; and presence of associated cardiovascular anomalies. The flow characteristics of the SVAs and its associated lesions were also evaluated by color and spectral Doppler imaging. These echocardiographic characteristics were then compared with the operative findings at surgery.

2.3. Classification of the SVAs

The SVAs arising from the right coronary sinus were classified roentgenologically according to the method of Sakakibara and Konno [3]:

Type I: left part of the sinus rupture or protrusion into upper portion of RVOT;

Type II: central part of the sinus rupture or protrusion into mid-portion of RVOT through supraventricular crest;

Type IIIv: rupture or protrusion into right ventricle near or at tricuspid annulus;

Type IIIa: rupture or protrusion into right atrium.

The SVAs arising from the non-coronary sinus were classified roentgenologically according to the method of Guo [4]:

Type I: rupture or protrusion into right atrium not near the tricuspid annulus;

Type IIa: rupture or protrusion into right atrium near or at the tricuspid annulus;

Type IIv: rupture or protrusion into right ventricle near or at the tricuspid annulus.

3. Results

The comparison of the echocardiographic and surgical findings of the 212 SVA patients was listed in Table 1.

3.1. Distribution of 212 cases of SVA

3.1.1. Origin of SVA

The aneurysms originated from the right, non-, multiple and left coronary sinus in 77.8%, 19.3%, 2.4% and 0.5%, respectively. All sinuses were enlarged, with no definite aneurysm in 4 and the aneurysm originating from both the right and non-coronary sinuses in 1.

3.1.2. Termination of SVA

The most common protrusion or rupture of the SVA was into the right ventricle (67.9%), followed by the right atrium (27.4%). Other rare terminations included extracardiac sites in 4, left ventricle in 2, left atrium in 1, interatrial septum in 1, interventricular septum in 1 and pulmonary artery in 1. 71.7% of the SVAs were ruptured.

3.1.3. Classification

Of the 165 SVAs arising from the right coronary sinus, 164 were classified by the Sakakibara method [3] into 47.6% type I, 33.5% type II, 6.1% type IIIv and 12.8% type IIIa; the remaining one ruptured into both the right ventricle and the right atrium. Of the 41 SVAs arising from the non-coronary sinus classified by the Guo method [4], 61.0% were type I, 34.1% type IIa and 4.9% type IIv.

3.1.4. Complications of the SVAs

The common complications of SVAs included insufficiency of the involved valves (59 cases of aortic regurgitation and 16 of tricuspid regurgitation were corrected by surgery) and obstruction of the termination chamber due to space-occupying effect of the aneurysm (19). Other complications included aneurismal vegetations (7), conduction disturbances (3), thrombus in the aneurismal body (2) and segmental wall motion abnormality due to compression of the left coronary artery (1).

3.1.5. Associated cardiovascular lesions

9 types of associated cardiovascular lesions were found in these patients. The three most common lesions were ventricular septal defect (VSD) (53.3%), stenosis of the RVOT (RVOTS) (7.5%), and aortic valvular malformation (5.2%). Other associated cardiovascular lesions included atrial septal defect or patent foramen ovale (8), stenosis of left ventricular outflow tract (5), dextrocardia (1), cor triatrium (1), abscess of tricuspid valve (1) and dissection of the aneurismal wall (1).

3.2. Diagnostic accuracy of echocardiography

Compared with the surgical findings, the sensitivity, specificity and accuracy of echocardiography in the diagnosis of SVAs were 93.9%, 99.9% and 99.8%, respectively (Table 2). For 13 overlooked SVAs, 77% were small aneurysms of the right coronary sinus extending into the right ventricle across the VSD. Of the 199 cases diagnosed by echocardiography before surgery, the diagnostic accuracy of aneurismal origination, termination and whether ruptured or not was 99.0% (197/199), 99.0% (197/199) and 97.5% (194/199), respectively. Echocardiography also accurately diagnosed the complications of SVAs

Table 1
Comparison of echocardiography and surgery.

	Case	Origin					Destination								Rupture		Associated cardiovascular lesions				
		RCS	NCS	LCS	RCS + NCS	All sinuses	RV	RA	LV	IVS	IAS	PA	RA + RV	Extracardiac	Unrupt-	Rupt-	VSD	RVOTS	AVM	ASD/PFO	Others
Echo	199	156	38	1	0[a]	4	133	56	2	1	1	1	1	4	48	151	110	8	11	6	4
Surgery	212	165	41	1	1	4	144	58	2	1	1	1	1[b]	4[c]	60	152	113	16	11	8	9

ASD: atrial septal defect; AVM: aortic valvular malformation; IAS: interatrial septum; IVS: interventricular septum; LA: left atrium; LCS: left coronary sinus; NCS: non-coronary sinus; PA: pulmonary artery; PFO: patent foramen ovale; RA: right atrium; RCS: right coronary sinus; RV: right ventricle; RVOTS: stenosis of right ventricular outflow tract; VSD: ventricular septal defect.

[a] Aneurysm originating from the NCS was miss-diagnosed by echo.

[b] Aneurysm of the RCS ruptured into the RV and RA simultaneously in 1.

[c] All sinuses were involved in 4.