Coronary sinus dilatation

A simple additional echocardiographic indicator of severe rheumatic mitral and tricuspid valve disease

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ABSTRACT

الأهداف: تقييم فعالية فحص قطر تشريح الجيب التاجي (CS) كعامل إضافي لحدة أمراض الصمام الروماتيزمي المزمنة (RVD).

الطريقة: قمنا بتحليل حالة 88 مريض عن طريق تصوير صدى القلب والذين يعانون من RVD وحالة 104 شخص سليم بقسم أمراض القلب – كلية الطب – جامعة جازينتاب – تركيا خلال الفترة من فبراير 2007 حتى أبريل 2007م. تم الحصول على ارتجاف الصمام، و التضييق، ووظيفة البطين الأيسر، وحجم الشريان الأيسر/الأيمن، والضغط الشرياني الرئوي. تم تقييم الجيب التاجي كشفافية الموجات الصوتية في أخدود شريان البطين الخارجي.

النتائج: كان هنالك علاقة إيجابية قوية حاضرة بين قياسات CS، ومتوسط التدرج المترالي، ودرجة الارتجاف المترالي، وثلاثي الشرف وتدرج تضيق ثلاثي الشرف، والضغط الإنقباضي للشريان الرئوي، وحجم الشريان الأيمن والأيسر، ورابطة نيويورك للقلب. كانت هنالك علاقة إحصائية سالبة حاضرة بين قياسات CS ومنطقة الصمام المترالي ونسبة الطرح الجزئي. كانت منطقة الصمام المترالي فقط ودرجة الارتجاف في الصمام ثلاثي الشرف وحجم الشريان الأيمن عوامل تنبؤ لتمدد متوسط المعدل CS لمنطقة سطح الجسم.

خاتمة: في هذه الدراسة الأولية قدمنا تقييم تصوير صدى القلب CS للجيب التاجي المتمدد و عرضنا معلومات إضافية مفيدة، لتنبؤ حدة RVD للصمام ثلاثي الشرف والصمام المترالي. تحتاج نتائج هذه الدراسة إلى التأكيد في الدراسات المستقبلية.

Objectives: To evaluate the usefulness of examining the coronary sinus (CS) anatomic diameter as an additional surrogate marker of severity in chronic rheumatic valve disease (RVD).

Methods: In this cross-sectional observational study, we echocardiographically analyzed 88 patients with RVD, and 104 normal subjects in the Department of Cardiology, Gaziantep University Medical Faculty, Gaziantep, Turkey between February 2007 and April 2007. Echocardiographically all valve regurgitation, stenosis, left ventricular function, left/right atrial volume, and pulmonary artery pressure were obtained. Coronary sinus was assessed as a sonolucency in the posterior atrioventricular groove.

Results: Strong positive correlation was present between CS measurements and mitral mean gradient, mitral and tricuspid regurgitation grade, tricuspid stenosis gradient, pulmonary artery systolic pressure, left and right atrial volume, and New York Heart Association class. A statistically negative correlation was present between CS measurements and mitral valve area and ejection fraction. Only the mitral valve area, tricuspid regurgitation grade, and the right atrial volume were predictors of body surface area adjusted mean CS dilatation.

Conclusion: In this preliminary study, we showed that echocardiographic assessment of dilated CS may provide useful additional information in predicting the severity of mitral/tricuspid RVD. Findings of this study needs to be confirmed in further studies.

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In the developing countries, rheumatic fever and rheumatic valve disease (RVD) remains a significant medical and public health problem.[1,2] Rheumatic valve disease is endemic in the Southeastern Anatolia region.[3,4] A considerable number of young adults are in need of valve surgery. The primary consideration in the management of adults with valvular heart disease is inquired on symptom status. Besides assessment of valve anatomy, alteration of symptoms due to chronic RVD is important during followup.[1] It is well known that symptom onset is an indication of surgery even in the setting of preserved left ventricular function. However, since the subjective nature of symptoms and feeling variabilities are existing in some subjects, echocardiographic evaluation became indispensable in routine practice. Moreover, echocardiographic screening of asymptomatic patients who have severe RVD remains the best tool for risk stratification and surgical indication.[1,2] Attentive echocardiographic evaluation for objective signs of severity and complication of valve disease is recommended for patients with doubtful symptoms. However, in routine practice, echocardiography may provide sub-optimal information on valve anatomy in some patients. We aimed to evaluate the usefulness of examining the coronary sinus (CS) anatomic diameter as an additional surrogate marker of severity in chronic RVD.

Methods. Patients with RVD, referred to a single cardiac center for echocardiography in the Department of Cardiology, Gaziantep University Medical Faculty, Gaziantep, Turkey between February 2007 and April 2007, and who met the entry criteria for the study were invited to participate. Eighty-eight consecutive patients with echocardiography documented RVD (mean age; 44 ± 15), and healthy subjects (mean age; 40 ± 11) with normal echocardiography were enrolled in the study. Patients with any of the following were excluded: history of myocardial infarction, previous cardiac surgery, blood pressure >140/90 mm Hg, abnormal plasma creatinine level, presence of moderate or severe respiratory disease, malignant or hematological disease, ECG rhythm other than sinus rhythm, and presence of local or systemic infection. The study was approved by the Local Research Ethics Committee, and all subjects provided their informed consent. The presence or absence of symptoms was assessed by 2 cardiologists blinded to the patients' echocardiographic results. Patients were categorized according to their New York Heart Association (NYHA) functional class.[5] All patients' body surface area (BSA) were estimated. Complete transthoracic echocardiography was performed in all subjects (Vivid 7, GE Vingmed Ultrasound AS, Horten, Norway) by 2 cardiologists as in a previous study.[6] All patients underwent a detailed transthoracic echocardiographic examination, including M-mode, 2-dimensional, and Doppler echocardiography. The left atrial diameter was measured from the parasternal long-axis view. The left ventricular end-systolic and end-diastolic volumes, and ejection fraction was estimated from the apical 4-chamber view using the modified Simpson's single plane method.[7] The severity of mitral regurgitation was determined from the regurgitant fraction,[8] and vena contracta width.[9] The mitral valve area was estimated using planimetry or pressure half-time methods. Mitral stenosis was graded as follows:[7] mild = valve area 1.6-2.0 cm^2 and mitral mean gradient <5 mm Hg, moderate = valve area 1.1-1.5 cm^2 and mitral mean gradient 5-10 mm Hg, severe = valve area 1.0 cm^2 or smaller, and mitral mean gradient >10 mm Hg. Aortic valve regurgitation was determined from the ratio of aortic regurgitant width to left ventricle (LV) outflow tract width. Mitral, aortic and tricuspid valve regurgitation were graded as one (mild), 2 (moderate), or 3 (severe).[7] A tricuspid mean gradient of >4 mm Hg was accepted as severe tricuspid stenosis, and a transaortic valve maximum gradient of >50 mm Hg was accepted as hemodynamically significant aortic valve stenosis.[7] Pulmonary artery systolic pressure was measured from tricuspid regurgitation according to the Bernoulli formula. Coronary sinus is a tubular structure, which can be imaged echocardiographically as a sonolucency in the posterior atrioventricular groove.[10] As the maximum CS occurs during ventricular systole,[10] measurement was performed in the ventricular systole (**Figure 1**). Three measurements were obtained as follows: at the termination of the CS orifice, one cm at its left side and between the orifice, and the left side origin. All provided values in cm are adjusted according to the patient BSA (measured values/BSA).

Data were analyzed using the Statistical Package for Social Sciences (SPSS Inc., Chicago, IL., USA) version 10.0. Numerical values were reported as mean ± SD, or as a proportion of the sample size. For the bivariable analysis, when the variables were parametric, the difference of averages test (student's t-test) was used, in the case of variables with more than 2 categories, the one-way ANOVA test was carried out. Discrete variables were expressed as counts or percentages, and compared using the χ^2 test. The correlation between 2 variables was studied with the Pearson test, depending on whether the variables had normal (parametrical) distribution, or not. In all analyses, a p-value of <0.05 was considered statistically significant. Multivariate analysis was performed using linear regression analysis. We used BSA-adjusted mean CS dilatation as a dependent

variable. The ability of the mean CS diameter to predict mitral regurgitation and tricuspid regurgitation was assessed with receiver operating characteristics curves (ROC).

Results. We echocardiographically analyzed 88 patients and 104 normal subjects. There was no difference in terms of age and gender between the 2 groups. The demographic characteristics of the groups are shown in **Table 1**. The correlation between BSA-adjusted CS measurements and all echocardiographic parameters are shown in **Table 2**. A statistically strong positive correlation was present between BSA adjusted CS measurements and mitral mean gradient, mitral and tricuspid regurgitation grade, tricuspid stenosis gradient, pulmonary artery systolic pressure, left and right atrial volume, and NYHA class. A statistically negative correlation was present between BSA adjusted CS measurements and mitral valve area, and LV ejection fraction (**Table 2**). The following variables were included for predictors of BSA-adjusted mean CS dilatation (dependent variable): mitral mean gradient, mitral valve area, tricuspid and mitral regurgitation grade, LV ejection fraction, right and left atrial volume. Only the mitral valve area (β = -2.1; p= 0.03), tricuspid regurgitation grade (β = 0.6; p< 0.001), and right atrial volume (β = 0.3; p= 0.03) were predictors of BSA-adjusted mean CS dilatation. The area under the ROC curve (AUC) for predicting the existence of mitral regurgitation was 0.582 (95% confidence interval [CI]; 0.472-0.686; p=0.317). This means that CS diameter does not predict mitral regurgitation. However, it can predict the severity of mitral regurgitation. The AUC for predicting the existence of tricuspid regurgitation was 0.812 (95% CI; 0.715-0.888; p=0.0001). The CS diameter of >0.4534 cm had a sensitivity of 70.5%, and a specificity of 84.1% for predicting the existence of tricuspid regurgitation. The AUC for predicting severe mitral regurgitation was 0.659 (95% CI; 0.550-0,756; p=0.0378). The CS diameter of >0.474 cm had a sensitivity of 61%, and a specificity of 70% for predicting severe mitral regurgitation (**Figure 2**). The AUC for predicting severe tricuspid regurgitation was 0.927 (95% CI; 0.851-0.971; p=0.0001). The CS diameter of >0.474 cm had a sensitivity of 100%, and a specificity of 76.7% for predicting severe tricuspid regurgitation (**Figure 3**).

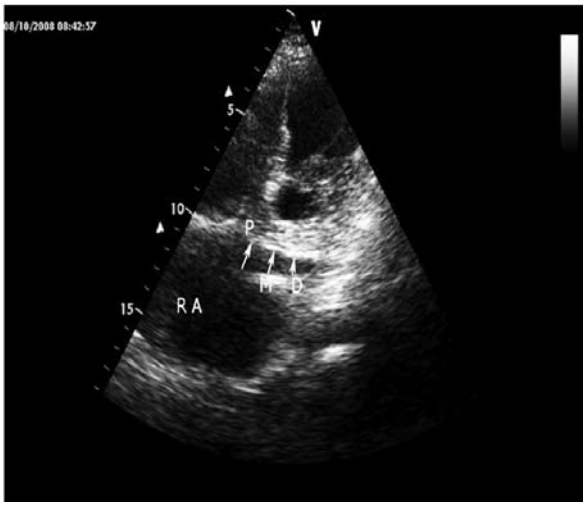

Figure 1 - Note the image of coronary sinus as tubular structure with sonolucency in the posterior atrioventricular groove. P (proximal), M (mid), and D (distal) mark of coronary sinus measurement are shown. RA - right atrium.

Discussion. In investigating the interrelation of BSA-adjusted CS dilatation on severe RVD, we found that severe mitral and tricuspid stenosis, severe mitral and tricuspid regurgitation, depressed LV, biatrial dilatation, poor NYHA class, and increased pulmonary artery systolic pressure were strongly associated with CS dilatation. By linear regression analysis, severe mitral

Table 1 - Echocardiographic characteristics of the 2 groups.

Variables	Patient (n=88)	Control (n=104)	*P*-value
Age, years (mean)	44 ± 15	40 ± 11	NS
Women (%)	(71)	(68)	NS
NYHA class 2 (%)	(15)	(0)	
NYHA class 3 (%)	(16)	(0)	
NYHA class 4 (%)	(4)	(0)	
MVA, mean (cm^2)	1.7 ± 0.6	5.5 ± 0.2	0.0001
Moderate MS, n (%)	18 (20)	(0)	
Severe MS, n (%)	7 (8)	(0)	
Mitral mean gradient (mm Hg)	8.7 ± 4.1	2.0 ± 1.2	0.0001
Moderate MR, n (%)	33 (37.5)	(0)	
Severe MR, n (%)	18 (20)	(0)	
AS (%)	(10)	(0)	
Moderate AR, n (%)	18 (21)	(0)	
Severe AR, n (%)	8 (9)	(0)	
Moderate TR, n (%)	17 (20)	(0)	
Severe TR, n (%)	15 (17)	(0)	
CSprx/BSA, mean	0.9 ± 0.3	0.7 ± 0.1	0.0001
CSmid/BSA, mean	0.8 ± 0.3	0.6 ± 0.1	0.0001
CSdist/BSA, mean	0.9 ± 0.2	0.5 ± 0.1	0.08
CSmean/BSA, mean	0.8 ± 0.3	0.6 ± 0.1	0.001
EF, mean (%)	61.7 ± 7.4	64.2 ± 2.4	0.001
BSA, mean (m^2)	1.7 ± 0.17	1.7 ± 0.18	NS
LAV, mean (cm^3)	23.9 ± 9.3	12.7 ± 6.7	0.0001
RAV, mean (cm^3)	20.1 ± 12.0	10.4 ± 2.6	0.01
PASP, mean (mmHg)	35.7 ± 14.1	15.3 ± 3.5	0.0001
LVDD, mean (cm)	4.9 ± 0.6	4.7 ± 0.3	NS
LVSD, mean (cm)	3.2 ± 0.6	2.8 ± 0.1	0.0001

MVA - mitral valve area, MS - mitral stenosis, MR - mitral regurgitation, AS - aortic stenosis, AR - aortic regurgitation, TR - tricuspid regurgitation, TS - tricuspid stenosis, CSprx - coronary sinus proximal, CSmid - coronary sinus middle, CSdist - coronary sinus distal, EF - ejection fraction, BSA - body surface area, LAV - left atrial volume, RAV - right atrial volume, PASP - pulmonary artery systolic pressure, LVDD - left ventricle diastolic diameter, LVSD - left ventricle systolic diameter

Table 2 - The statistical correlation between BSA-adjusted coronary sinus measurements and all echocardiographic parameters.

Parameters	CSprx/BSA R	*P*-value	CSmid/BSA R	*P*-value	CSdist/BSA R	*P*-value
Mitral mean gradient	0.497	0.00001	0.438	0.00001	0.262	0.00001
MVA	-0.444	0.00001	-0.425	0.00001	-0.194	0.007
MR grade	0.174	0.01	0.181	0.01	NS	-
AS grade	NS	-	NS	-	NS	
AR grade	0.135	0.06	NS	-	NS	
TR grade	0.627	0.00001	0.650	0.00001	0.320	0.00001
TS grade	0.177	0.01	0.137	0.05	NS	
PASP	0.534	0.00001	0.514	0.00001	0.289	0.00001
EF	-0.211	0.003	-219	0.002	-0.135	0.06
LVDD	NS		NS		NS	
LVSD	NS		NS		NS	
LAV	0.388	0.00001	0.393	0.00001	NS	
RAV	0.669	0.00001	0.731	0.00001	NS	
NYHA	0.552	0.00001	0.536	0.00001	0.277	0.00001

R - correlation coefficient, MAV - mitral valve area, MR - mitral regurgitation, AS - aortic stenosis, AR - aortic regurgitation, TR - tricuspid regurgitation, TS - tricuspid stenosis, CSprx - coronary sinus proximal, CSmid - coronary sinus mid, CSdist - coronary sinus distal, EF - ejection fraction, BSA - body surface area, LAV - left atrial volume, RAV - right atrial volume, PASP - pulmonary artery pressure, LVDD - left ventricle diastolic diameter, LVSD - left ventricle systolic diameter

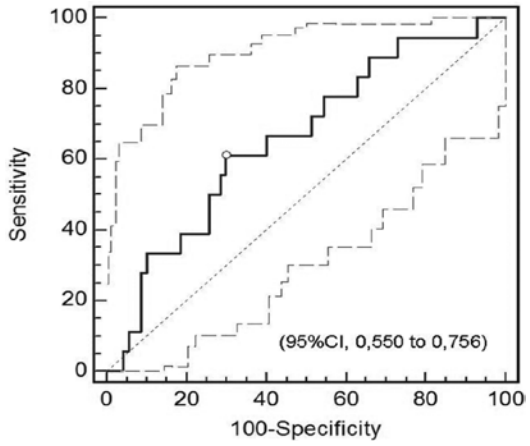

Figure 2 - Receiver operating characteristic (ROC) curves for the ability of mean coronary sinus diameters to predict severe mitral regurgitation.

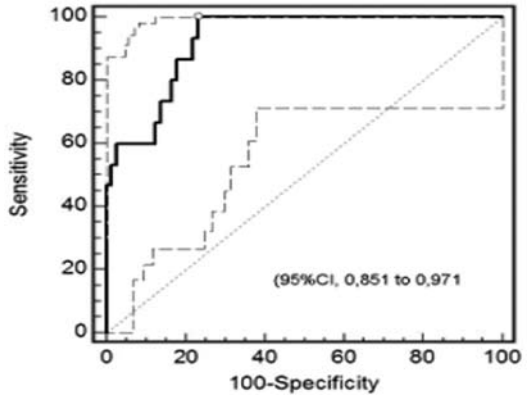

Figure 3 - Receiver operating characteristic (ROC) curves for the ability of mean coronary sinus diameters to predict severe tricuspid regurgitation.

stenosis, severe tricuspid regurgitation, and right atrial dilatation were predictor of CS dilatation. In this study, severity of aortic stenosis, severity of aortic regurgitation, and LV diastolic/systolic diameters were not related with CS dilatation.

In this study, we established firstly the usefulness of echocardiographic measures of CS dilatation as assessing severe rheumatic mitral and tricuspid valve disease. Coronary sinus evaluation during echocardiographic examination is generally ignored, and the significance of its anatomic diameter significance has not been investigated. We clearly demonstrated that in routine practice, there is an additional important role of the echocardiographic examination of CS anatomic diameter in assessing the severity of the mitral and tricuspid RVD. From this angle, echocardiographic assessment of CS dilatation might be recommended for risk stratification and surgical indication during echocardiographic screening of asymptomatic patients, or with doubtful symptoms who have RVD. It has been shown that experimentally, a significant reflux of the right atrial blood into the CS occurs with increasing right atrial pressure.[11] In our study, we found that severe mitral stenosis and regurgitation, which increased pulmonary artery systolic pressure resulted in increased atrial pressure, thus, they may cause a significant reflux of right atrial blood into the CS. Furthermore, our finding of a strong relation of increased right atrial volume with CS dilatation further support our mechanistic hypothesis. In our view, the same potential pathophysiologic link is present between severe tricuspid regurgitation/stenosis and CS dilatation. Another potential mechanism between CS dilatation

and severe mitral/tricuspid valve disease might be a theory of retrograde flow into the CS. A patient with pulmonary hypertension and moderate tricuspid regurgitation where the CS was dilated and the tricuspid jet was directed selectively into the CS might be the other potential mechanism.[10] Our findings support this theory. One of the causes of CS dilatation in the setting of severe mitral and tricuspid valve diseases might be the presence and coexist of pulmonary hypertension and tricuspid regurgitation. Our findings are in accordance with the findings of Gunes et al[12] that demonstrated the presence of a positive correlation between CS dilatation and pulmonary hypertension in some diseases, other than rheumatic valve causes. Also in their study, they demonstrated that a negative correlation was present between CS dilatation and ejection fraction, which is similar to the findings in our study.

This study was limited by the small number of the study group, and subjective evaluation of the NYHA functional class. The results of this study cannot be applied to patients with atrial fibrillation. Additionally, we cannot determine the influence of the drugs used on CS dilatation. The impact of Steres test, LV mass, and vigorous use of diuretic and vasodilator therapy on CS diameter needs to be assessed. The CS can be visualized and quantitatively assessed further by a 3-dimensional real-time echocardiography.[13]

In conclusion, echocardiographic assessment of a dilated CS may provide useful additional information, predicting the severity of mitral/tricuspid RVD. The findings of this preliminary study needs to be confirmed in further studies.

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