

Coronary Morphology and Conduction System Disturbance Induced by Therapeutic Embolization of the Coronary Septal Artery

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ABSTRACT

Background: Percutaneous transluminal septal myocardial alcohol ablation (PTSMAA) is not a procedure without complications. It may produce heart arrhythmias, especially those due to disturbances of atrioventricular (AV) and inter-ventricular (IV) electrical conduction.

Objective: The goal of this study was to evaluate the relationship between the anatomical patterns of the right coronary artery and the left anterior descending artery (LAD) and to relate them to the AV and IV bundle branch blocks provoked by PTSMAA.

Method: Twenty patients with obstructive hypertrophic cardiomyopathy resistant to treatment with drugs successfully underwent PTSMAA. Electrocardiographic analyses were done before and after PTSMAA, and the results were compared with the abnormal septal anatomy.

Results: The effectiveness of PTSMAA was obtained in 18 (90%) of the 20 patients by ethanolization of the first great septal branch. In the other 2 patients (10%), 2 septal branches underwent alcoholization. First-grade temporary AV block (AVB) was observed in 6 patients (30%). Ten patients experienced severe bradycardia due to total AVB that required a temporary pacemaker, but 3 of the patients (15%) required a permanent pacemaker. Fourteen patients (70%) experienced permanent complete right branch block, and 2 developed incomplete left anterior block and incomplete left posterior block. Six patients presented with no electrical conduction disturbance at all.

Conclusion: According to the results of the present investigation with the AV node artery derived from the right coronary artery in all cases, complete and permanent AV conduction system blockade occurred after PTSMAA in all types of anatomy regarding the observed LAD.

INTRODUCTION

Hypertrophic cardiomyopathy (CMH) is a congenital primary heart disease with a polygenic genetic basis and an

autosomal dominant pattern of inheritance. It is characterized by a varying degree of left ventricular hypertrophy without any other causes of increase in the myocardial mass. Ventricular hypertrophy in most cases has a greater expression in the interventricular septum than in the left ventricular free wall. The treatment for CMH is always individualized and is recommended to symptomatic patients to improve their quality of life, to improve the natural history and evolution of the disease, and to prevent complications, particularly sudden death.

A little more than a decade ago, Sigwart [1995], followed by Knight et al [1997], developed a method for reducing an abnormally hypertrophied septal mass by inducing an infarct of the local myocardium via total occlusion of the septal artery that nourishes this area; this infarct is produced by infusing ethyl alcohol. The goal is to reduce the intraventricular pressure gradient via infarct reduction of the extent of the proximal hypertrophied septum obstructing the left ventricle outlet.

Several subsequent studies [Kuhn 1997; Marin-Neto 1998; Osterne 2003, 2004; Coelho 2008] confirmed the effectiveness of permanent interruption of the septal artery via this method, and the good initial results were sustained in the midterm follow-up. However, several publications emphasized the complications of the procedure, mainly with respect to those that create arrhythmias. Of these causes, those that stand out are disturbances in atrioventricular (AV) and intraventricular transport, primarily blockages of the right branch of the bundle of His. Alam et al [2006] reviewed the literature and reported an early-mortality rate of 1.5% and a late mortality rate of 0.5% (range, 0%-9.3%). Other complications included ventricular fibrillation (2.2%), complete AV block (AVB) requiring a permanent pacemaker (10.5%), and pericardial effusion (0.6%). The electrocardiographic alterations found were complete blockage of the right branch of the bundle of His in 46% of the patients (range, 0.0%-76%) and complete blockage of the left branch in 6% of the patients (range, 0.0%-17.2%).

Qin et al [2001] observed the repercussions of percutaneous transluminal septal myocardial alcohol ablation (PTSMAA) and septal myectomy in the conduction system of patients with obstructive CMH and analyzed the electrocardiogram and Doppler echocardiograms of 204 patients who underwent PTSMAA (n = 70) or myectomy (n = 134) before and at 3 months after the intervention. Of the 146 patients

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with normal electrocardiograms before the intervention, the QRS duration was significantly prolonged, from 98.15 milliseconds to 130.25 milliseconds ($P < .0001$), with right branch blockage observed in 62% of the patients after septal ablation and complete left branch blockage observed in 93% of the patients after surgical myectomy. The QRS duration was an independent predictor of a need for a permanent pacemaker ($P < .0001$). These investigators concluded that because complete blockage of the left branch is quite frequent after myectomy and blockage of the right branch also can occur after PTSMAA, the procedure that carries the lesser risk should be selected for patients presenting with such conduction disturbances.

The objective of the present study was to analyze the influence of the coronary anatomy on the incidence of electrocardiographic alterations induced by embolic septum ablation.

MATERIALS AND METHODS

Twenty patients (50% female) with a mean age of 44 years (range, 26-66 years) had a diagnosis of obstructive CMH that was confirmed by a physical examination, Doppler echocardiography, and hemodynamic and angiographic heart studies. The patients were resistant to clinical pharmacologic treatment and were in New York Heart Association (NYHA) functional classes III and IV (Table 1). These 20 patients were selected for the present study and underwent PTSMAA via embolization of the septum artery. The technical procedures, which have already been described, involve the infusion of 3 mL of absolute alcohol per patient and monitoring of heart enzyme levels and electrocardiograms in the intensive care unit for 48 hours.

All of the patients opted for the percutaneous procedure and agreed to participate in the present research by signing an informed-consent form, in accordance with Research

Ethics Resolution 196 of National Health Council/MS 46 (1996). Thirteen patients were registered in the Hospital of the Armed Forces, and 7 patients originated from the Heart Institute of Taguatinga. Both institutions are located in Federal District of Brazil. The studies were carried out after approval by the Committees of Ethics in Research in Human Beings of the referred centers.

As part of the methodology for performing the PTSMAA procedures, all of the selected patients underwent the first phase of the study as a clinical consultation with preoperative examinations that included electrocardiograms and color Doppler echocardiography.

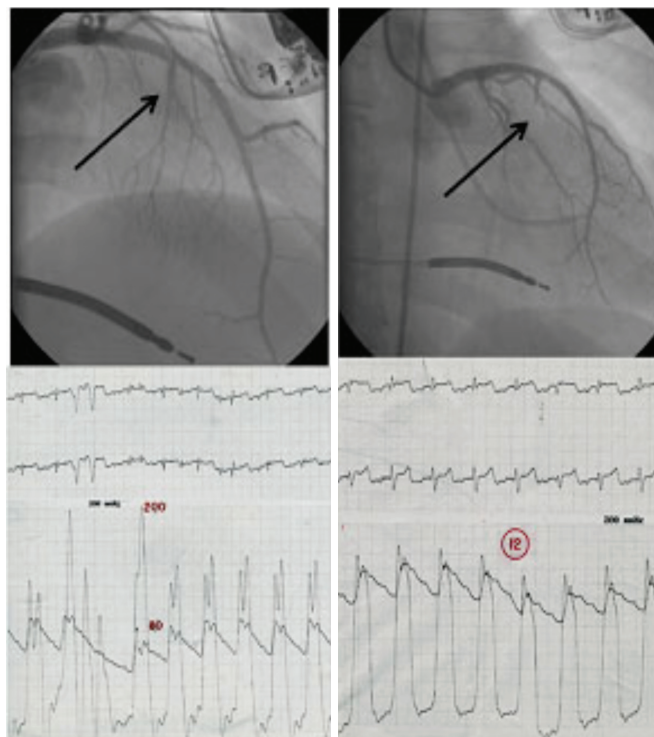
Diagnosis of obstructive CMH was confirmed before the PTSMAA procedure, along with exclusion of other possible causes for the failure of the clinical treatment, such as the existence of a significant pressure gradient in the aortic valve or coronary arterial disease.

A surface electrocardiogram with the standard 12-lead pattern was obtained from all of the patients immediately before the procedure, after the procedure, and in the outpatient clinic of the hospital, primarily to diagnose the presence or absence of heart conduction system blockade, which was defined according to criteria standardized by the Brazilian Society of Cardiology [Guimarães 2003]. The results were analyzed and compared with respect to the anatomy of the main septum arterial trunk, particularly the importance of the coronary artery of origin (considering the Schlesinger classification of right or left coronary artery dominance and

Table 1. Patients' Clinical Data*

Mean age (range), y	44 (26-66)
Male sex, n	10
History, mo	17-37
Family history of sudden death, n	3
Complications/symptoms, n	
Dyspnea	12
Syncope	8
Sharp atrial fibrillation	2
Angina	16
NYHA class, n	
III	15
IV	5
Medications in use	β -Blockers, calcium blockers, diuretic (isolated or associated)

*NYHA indicates New York Heart Association.



Successful septum ablation with amputation (arrows) of the great forked septum branch and implantation of a cardioverter-defibrillator electrode.

the InCor classification [Schlesinger 1938, 1948; Didio 2002; Guimarães 2003]) for the functional importance of the left anterior interventricular descending artery (LAD): type I, first third of the anterior interventricular groove; type II, second third of the anterior interventricular groove; type III, reaching the apex; and type IV, continuing through the posterior interventricular groove (left dominance Schlesinger standard).

RESULTS

None of the 20 analyzed patients presented with basal disturbance of the heart conduction system. Eighteen of the 20 patients (90%) had their intraventricular pressure gradient corrected via embolization of the single main septum artery (the first largest, located in the proximal third of the anterior descending artery). Two patients required embolization of 2 septum branches to achieve equalization of the pressures; the second septum branch was located in the medium third of the anterior descending artery in both cases.

Sinus rhythm was observed immediately after the alcohol injection (Table 2) in 12 patients (60%), with an abnormal increase in the PR interval. Fourteen patients (70%), including 12 patients presenting with first-degree AVB, developed complete AVB with intense bradycardia that required right ventricular stimulation with a temporary pacemaker. Three of these 14 patients (15% of the total) required permanent implantation of a DDD-type pacemaker (Figure).

Analysis of the coronary anatomies of the 20 patients revealed the presence of the AV node artery and its origin from the dominant right coronary artery in all cases. Regarding the LAD, no patients presented with type I morphology. Thirteen patients (65%) presented with a type III LAD standard morphology, 5 (25%) presented with a type II morphology, and only 2 (10%) presented with a type IV morphology. Permanent AVB occurred in 1 (50%) of the 2 patients with a type II LAD morphology and in 2 (15%) of the patients with a type III LAD morphology. One of the patients with a type IV LAD presented with a transitory AVB that showed complete morphologic recovery in an electrocardiographic evaluation.

DISCUSSION

The results of the present study confirm the published data about the effectiveness of the septum ablation with alcohol for treating obstructive CMH as a valid alternative to direct surgical ablation in selected cases.

Recent studies that have compared myectomy with PTSMAA have highlighted the disturbances of AV and intraventricular transport of the cardiac electrical stimulus as complications of both procedures [Lumb 1962; Chahine 1991; Sigwart 1995]. In patients without previous transport disturbances who undergo the direct septal myectomy, the incidence of complete left branch block is approximately 90%. For PTSMAA, complete right branch block of the His bundle occurs in approximately 60% to 70% of the patients with a normal QRS complex. These data confirm the worse

Table 2. Conduction System Disturbances after Alcohol Septum Ablation*

RBBB, n	14 (70%)
CRBB-LAHBB, n	1 (5%)
CRBB + LPHBB, n	1 (5%)
CLBB, n	0
First-degree AVB, n	12 (60%)
Permanent AVB, n	3 (15%)

*RBBB indicates right bundle branch block; CRBB, complete right branch block of the His bunch; LAHBB, left anterior half branch block; LPHBB, left posterior half branch block; CLBB, complete left branch block; AVB, atrio-ventricular block.

arrhythmia prognosis for septum ablation in patients with pre-operative disturbances in the conduction system. PTSMAA in patients with a previous complete right branch block of the His bundle or a complete left branch block may lead to permanent AVB in >50% of patients; however, the incidence of AVB may reach 90% or greater after direct surgical ablation in patients with previous right or left bundle branch blockade [Chahine 1991].

Although the results were reduced in the present study, they confirm the experience reported worldwide of a high incidence of transitory complete AVB and partial conduction disturbance, mainly the right bundle branch block, with percutaneous transluminal alcohol septal ablation procedures [Runquist 2002].

The high incidence (70%) of complete AVB may emphasize the role of the first septal branch of the LAD, because in all cases of the present investigation, the artery of the AV node was a branch of the right coronary artery. The AV conduction normalization (55%) is attributable to the collateral circulation developed from the AV node branch of the right coronary artery. Although previous reports [Lumb 1962; Rodriguez 1962] described the artery of the AV node to originate from the right coronary artery in 86% of the cases, from the left circumflex artery in 12% of the cases, and from both arteries in 2%, it is remarkable that the AV node artery originated from the right coronary artery in all patients of the present study.

Regarding the LAD, no patients presented with a type I morphology. Thirteen patients (65%) presented with a type III LAD standard morphology, 5 (25%) presented with a type II morphology, and only 2 patients (10%) presented with a type IV morphology. Permanent AVB occurred in 1 (50%) of the 2 patients with a type II LAD and in 2 (15%) of the patients with a type III LAD. One of the patients with a type IV LAD presented with a transitory AVB with complete morphological recovery documented electrocardiographically. This result suggests, without statistical confirmation, the likelihood of better AVB protection in patients with a type III LAD.

Although it is not possible to establish scientific parameters for preventing lesions in the heart conduction system, another very important aspect supporting the PTSMAA

approach is that the presence of permanent AVB in a patient with an implanted DDD pacemaker does not change the patient's prognosis [Chang 2003]. The 3 described patients with an implanted DDD pacemaker were in good clinical condition in NYHA class I in a late-postoperative follow-up.

CONCLUSION

According to the results of the present investigation with the AV node artery originating from the right coronary artery in all cases, complete and permanent AV conduction system blockade occurred after PTSMAA in all types of anatomy relevant to the presented LAD.

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