Sustained Monomorphic Ventricular Tachycardia in a Patient With Brugada Syndrome

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We report a patient with Brugada syndrome who developed sustained monomorphic ventricular tachycardia (SMVT). The patient was a 29-year-old man who experienced recurrent episodes of palpitation and syncope after drinking alcohol. Electrocardiogram showed right bundle branch block and ST-segment elevation in precordial leads V1–3 without Q-Tc prolongation. Organic heart disease and coronary artery disease were excluded by noninvasive and invasive tests. Ventricular fibrillation was induced by the application of a single extrastimulus to the right ventricular outflow tract. During isoproterenol infusion, SMVT of left bundle branch block morphology (240/min) was induced by the application of a single extrastimulus to the right ventricular apex. SMVT also developed spontaneously. Pace mapping disclosed that SMVT originated at the free wall of the right ventricular outflow tract. Head-up tilt test and an alcohol provocation test both induced similar SMVT that was associated with hypotension and near syncope. SMVT was not terminated by intravenous administration of lidocaine, procainamide or adenosine triphosphate (10 mg), but was terminated by propranolol. Thus, a beta-adrenoceptor-mediated mechanism appears to play an important role in SMVT in this patient. The site of origin of SMVT might be closely related to the lesion that causes ST-segment elevation.

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In 1992, Brugada and Brugada described a distinct clinical and electrocardiographic syndrome (so called “Brugada syndrome”) which was defined by right bundle branch block, persistent ST-segment elevation in right precordial leads, and sudden cardiac death. Polymorphic ventricular tachycardia and ventricular fibrillation have been documented in patients with Brugada syndrome. We report here a patient with electrocardiographic characteristics of Brugada syndrome who developed sustained monomorphic ventricular tachycardia (SMVT) in response to beta-adrenoceptor stimulation, head-up tilt test, and alcohol consumption.

CASE REPORT

The patient was a 29-year-old Japanese man. He experienced his first episode of syncope after drinking alcohol at the age of 22. His second and third episodes of syncope occurred at the ages of 25 and 27, also after drinking alcohol. In all cases, syncope was preceded by palpitation. He was admitted to our hospital for the evaluation of syncope and electrocardiogram (ECG)

Key words:
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abnormalities.

On physical examination, he appeared well. Serum electrolytes were normal; sodium 139.2 mmol/L, potassium 4.1 mmol/L, chloride 104 mmol/L, calcium 9.0 mg/dl. Thyroid hormones were also normal; free triiodothyronine 3.1 pg/ml, free thyroxine 1.0 ng/dl, thyroid-stimulating hormone 0.9
Performed until the heart rate reached 90% of the predicted maximum value (170/min), but no arrhythmia or chest pain occurred. Holter monitoring revealed 2,061 isolated ventricular premature beats during a 24-h period, but no ventricular tachycardia or ventricular fibrillation was detected. The signal-averaged ECG showed a QRS duration of 151.5 msec, RMS of 8 μV, and a duration of late potentials <40 μV of 51.0 msec. Despite the presence of right bundle branch block and left anterior hemiblock, the latter 2 values were considered to suggest positive late potentials. ²⁰¹TI scintigraphy, ¹²³I-BMIPP scintigraphy, and ¹²³I-MIBG scintigraphy showed no abnormal defects. Left ventricular ejection fraction measured by technetium-99m radionuclide angiography was 58%. A magnetic resonance imaging study of the heart was normal.

Pressure values during cardiac catheterization were normal; right atrium 2 mmHg (mean), right ventricle 22/end-diastolic 6, pulmonary artery 18/9 (mean 12), pulmonary artery wedge 10 (mean), left ventricle 110/end-diastolic 9, and systemic aorta 100/70 (mean 80). Cardiac output measured by the thermodilution method was 2.77 l/min/m². Coronary angiography revealed no stenotic lesions. Coronary spasm was not induced by intracoronary injection of acetylcholine (up to 50 μg into the right coronary artery, up to 100 μg into the left coronary artery). Left ventricular ejection fraction measured by left ventriculogram was 62%. Right ventriculogram showed no structural abnormalities. An endomyocardial biopsy specimen obtained from the interventricular septum showed no abnormalities on histologic examination.

An electrophysiologic study revealed a normal corrected sinus node recovery time of 310 msec, and normal AV conduction with a Wenckebach cycle length of 330 msec. The HV interval was prolonged (85 msec). Under baseline conditions, ventricular fibrillation was induced by the application of a single extrastimulus (230 msec) to the right ventricular outflow tract (Fig 2), which was defibrillated by DC shock. During intravenous infusion of isoproterenol (1 μg/min), SMVT was induced by the application of a single extrastimulus to the right ventricular apex (Fig 2) and terminated.

μU/ml. Serum catecholamine levels at rest were normal; adrenaline 40 pg/ml (normal value: below 100 pg/ml), noradrenaline 190 pg/ml (normal value: 50–400 pg/ml).

ECG showed right bundle branch block and ST-segment elevation in leads V₁₋₃ with a normal O-Tc interval of 417 msec (Fig 1(A)). Left anterior hemiblock and first-degree ativoventricular block were also present. He had no family history of sudden death, but his father’s ECG revealed similar changes, including right bundle branch block, ST-segment elevation in leads V₁₋₂, and left anterior hemiblock (Fig 1(B)). No abnormality was found by echocardiography. Left ventricular wall motion and chamber sizes were normal; left ventricular diastolic and systolic diameters were 4.8 cm and 2.8 cm, respectively, and left atrial dimension was 2.2 cm. Treadmill exercise testing was

Fig 2. Ventricular tachyarrhythmias induced by programmed ventricular stimulation. Under baseline conditions (upper panel), ventricular fibrillation was induced by the application of a single extrastimulus (230 msec) to the right ventricular outflow tract (RVOT). During intravenous infusion of isoproterenol (lower panel), sustained monomorphic ventricular tachycardia was induced by the application of a single extrastimulus to the right ventricular apex (RVA). HBE: His bundle electrogram.
Fig 3. Sustained monomorphic ventricular tachycardia showed left bundle block morphology (240/min).

VT(+) VT(-) 

ECG
Finger Artery Pressure 150-100-50-

Fig 4. Head-up tilt test. Twenty-two min after the onset of 60 degree tilt, ventricular tachycardia (VT) developed and blood pressure declined.

by overdrive pacing. Spontaneous development of SMVT was also observed. SMVT showed left bundle block morphology (240/min) (Fig 3), and was associated with hypotension (60 mmHg). Pace mapping during sinus rhythm disclosed that SMVT originated at the free wall of the right ventricular outflow tract. After intravenous administration of 8 mg propranolol, ventricular fibrillation and SMVT were no longer induced by programmed ventricular stimulation.

To evaluate the etiology of recurrent episodes of syncope, we conducted a head-up tilt test. Heart rate and blood pressure (finger artery pressure) were monitored during the tilt test. Twenty-two minutes after the onset of 60 degree tilt, SMVT developed, and his blood pressure declined (Fig 4). SMVT was terminated by changing to the supine position, but recurred instantly. Intravenous administration of lidocaine (100 mg, twice) and procainamide (450 mg) failed to terminate SMVT. SMVT was terminated by intravenous administration
of 8 mg propranolol, and did not recur thereafter. The serum adrenaline level during SMVT was high; adrenaline; 131 pg/ml, noradrenaline; 319 pg/ml.

Since his episodes of syncope occurred after drinking alcohol, we performed an alcohol provocation test. 4 h after drinking 1500 ml of beer, SMVT (176/min) developed (Fig 5), and his blood pressure declined (76 mmHg). Intravenous administration of adenosinetriphosphate (10 mg) failed to terminate SMVT. In contrast, intravenous administration of propranolol terminated SMVT.

Oral administration of propranolol (30 mg/day) was started during hospitalization. After discharge, he has been asymptomatic on propranolol for 4 months.

**DISCUSSION**

It has been reported that patients with Brugada syndrome are at high risk of sudden cardiac death due to polymorphic ventricular tachycardia or ventricular fibrillation\(^1\)\(^{-7}\) (Table I). Although our case had no clinical evidence of ventricular fibrillation or aborted sudden cardiac death, ventricular fibrillation was induced by the application of a single extrastimulus to the right ventricular outflow tract. This suggests that our case had characteristics of Brugada syndrome. A hereditary factor may be involved in this case because the father's ECG resembled the patient's one. This speculation is consistent with 4 patients reported by Brugada and Brugada! In their report, 2 patients were siblings and the remaining 2 had a family history of sudden death.

The present case is unique in that the patient had Brugada syndrome and recurrent SMVT that was closely related to beta-adrenoceptor stimulation. SMVT appears to have caused syncope in our patient. It is not clear whether SMVT is due to reentry or triggered activity. The finding that SMVT was induced and terminated by a single extrastimulus may support a reentry mechanism. Idiopathic ventricular tachycardia originating from the right ventricular outflow tract in patients without structural heart disease is characteristically catecholamine-
TABLE I SUMMARY OF THE REPORTED CASES OF BRUGADA SYNDROME IN THE LITERATURES

<table>
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<tr>
<th>No.</th>
<th>References</th>
<th>Age</th>
<th>Sex</th>
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VF = ventricular fibrillation; NSPVT = nonsustained polymorphic ventricular tachycardia; SPVT = sustained polymorphic ventricular tachycardia; SMVT = sustained monomorphic ventricular tachycardia; ND = not done; AICD = implantable defibrillator.

sensitive, and is thought to be due to triggered activity. Kobayashi et al reported that ventricular tachycardia was terminated by intravenous administration of adenosine triphosphate (0.2 mg/kg), and suggested that cAMP-mediated triggered activity was the responsible mechanism. In our patient, intravenous injection of adenosine triphosphate (0.2 mg/kg) failed to terminate SMVT. This finding suggests that the mechanism of SMVT in our patient may be different from that of idiopathic ventricular tachycardias described by Lerman and Kobayashi et al.

In our patient, the administration of isoproterenol as well as the head-up tilt test and alcohol provocation test consistently induced SMVT, whereas it was terminated by propranolol. Both head-up tilt and acetaldehyde, a metabolite of alcohol, are known to cause sympathetic stimulation. Thus, a beta-adrenoceptor-mediated mechanism may play an important role in this SMVT. There are no other reports describing an association between SMVT and Brugada syndrome except for a case appearing in a column in New England Journal of Medicine. This patient had typical features of Brugada syndrome as well as exercise-induced monomorphic ventricular tachycardia of left bundle branch block morphology, similar to our patient. This evidence suggests that catecholamine-sensitive SMVT and Brugada syndrome might be linked pathophysiologically, although there is a possibility that the coexistence of these 2 conditions is coincidental. The origin of SMVT in our patient was localized at the free wall of the right ventricular outflow tract. We speculate that the origin of SMVT in our patient may be in a specific substrate causing ST-segment elevation in leads V₁₋₃.

Our patient was initially treated with oral
propranolol, because it terminated SMVT and prevented the recurrence of ventricular tachyarhythmias. Catheter ablation has recently become favored for the long-term cure of idiopathic ventricular tachycardia.\textsuperscript{13,14} We did not choose this approach for our patient because there was a possibility that the ablation procedure for ventricular tachycardia would not only fail to prevent ventricular fibrillation but actually promote it. If syncope in this patient recurs during beta-blocker therapy, an automatic implantable cardioverter/defibrillator would be the next choice of therapy.

REFERENCES

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