Case Reports

Possible Contribution of Ischemia of the Conus Branch to Induction or Augmentation of Brugada Type Electrocardiographic Changes in Patients With Coronary Artery Disease

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Summary

Recent evidence suggests an association between vasospastic angina and Brugada syndrome. Here we present two cases of coronary artery disease who presented with ECG abnormalities which might have been provoked or enhanced by ischemia of the conus branch of the right coronary artery. The 12-lead ECGs demonstrated normal sinus rhythm in these two cases. Interestingly, a saddle back or coved type ST segment elevation in leads V1-V3 was documented either in the percutaneous transluminal angioplasty procedure of the proximal right coronary artery or with an intracoronary acetylcholine (Ach) administration into the right coronary artery. These Brugada type ECG changes were restored to the baseline ECG waveform after improvement in the ischemia. In the second case, vasospasms of the conus branch of the right coronary artery were associated with a coved type ST segment elevation in leads V1 to V2. We discuss the possible interaction between ischemia caused by conus branch lesions and Brugada type electrocardiographic changes. (Int Heart J 2010; 51: 68-71)

Key words: Brugada type ECG, Conus branch, Ischemia

Recently, a possible association of vasospastic angina and Brugada syndrome has been reported in several cases. According to Noda, et al, the coexistence of vasospastic angina and Brugada syndrome was not rare (11%) and they hypothesized that mild ischemia and vagal influences act additively with the substrate responsible for the Brugada syndrome reported in the literature. When Brugada syndrome and vasospastic angina coexist, the risk of inducing life-threatening ventricular fibrillation caused by Brugada syndrome or coronary vasospasms would be high. On the other hand, the therapeutic strategy for the two diseases is quite different since Ca channel blockers may cause deteriorative effects in Brugada syndrome. In fact, Chinushi reported a case with Brugada syndrome and vasospastic angina in which there was shortening of the ventricular fibrillatory interval after the administration of verapamil. Thus, the interaction between Brugada type ECG abnormalities and vasospasms or ischemia is very important from the therapeutic point of view.

It is well known that the conus branch of the right coronary artery supplies the right ventricular outflow tract, and there are some reports regarding ischemia caused by conus branch lesions that may have induced Brugada type ECG changes. Recent experimental evidence has also suggested that acute global ischemia in right ventricular wedge preparations can cause a loss of the action potential dome, leading to ST-segment elevation similar to that in Brugada syndrome. Furthermore, a recent paper has shown that the occurrence of a J wave in the 12-lead ECG may be a marker for acute ischemia. In this paper, we present two cases with coronary artery disease who presented with ECG abnormalities which might have been provoked by ischemia of the conus branch of the right coronary arteries, and discuss the possible interaction between these two phenomena.

Case 1: A 68-year-old man with a history of chest pain was
admitted to our hospital for an angiographic study. Coronary angiography revealed a 90% stenosis of segment 1 of the right coronary artery. He had no history of syncope and there was no family history of sudden cardiac death. The 12-lead ECGs demonstrated normal sinus rhythm without any Brugada type ST segment changes. Subsequently, coronary angioplasty using a rotablator and cutting balloon was performed on the ostial region of the right coronary artery, causing severe stenosis with a delay in the conus branch (Figure 1). The ECG during the procedure revealed a coved type ST segment elevation in leads V1 to V2 and saddle back type ST segment elevation in lead V3 (Figure 2). When the delay in the conus branch flow recovered, the ST segment elevation also became restored.

**Case 2:** A 62-year-old man presented with chest pain at rest during the night and early morning. He had no history of faintness or syncope and there was no family history of sudden cardiac death. The 12-lead ECG on admission exhibited no ST segment elevation (Figure 3A). However, a coved-type ST segment elevation in leads V1 to V2 was observed at the time of the pilsicainide provocation test (that is, ST segment day-to-day variability was indicated), and those changes were augmented by the intravenous administration of 50 mg of pilsicainide, suggesting that this case was an asymptomatic patient with Brugada type ECG (Figure 3B). The echocardiogram and cardiac scintigram revealed no particular abnormalities.

On the coronary angiography, no stenosis was observed in the control (Figure 4A). On the other hand, intracoronary Ach administration into the right coronary artery caused an enhancement of the coved type ST-segment elevation in leads V1 to V2 associated with coronary vasospasms of the conus branch of the right coronary artery (yellow arrow) occurred.

**Figure 2.** ECG changes during PCI. A: During rotational atherectomy. B: During cutting balloon angioplasty. C: After right coronary stenting.

**Figure 3.** A: ECG on admission. B: ECG changes induced by the intravenous administration of pilsicainide.

**Figure 4.** Intracoronary acetylcholine administration into the right coronary artery. Note that the flow of the proximal (yellow arrow) and distal (red arrow) parts of the conus branch was inadequate. A: Control. B: After the administration of 50 μg of acetylcholine. C: After the administration of isosorbide dinitrate.

**Figure 5.** Intracoronary acetylcholine administration into the right coronary artery. (Expanded photographs) Note that coronary vasospasms of the conus branch of the right coronary artery (yellow arrow) occurred.
as demonstrated in Figure 6B, persisted for several minutes after the provocation with Ach and rapidly recovered to the baseline waveform after the administration of isosorbide dinitrate.

**Discussion**

The cellular mechanism underlying the Brugada type ST segment elevation is explained by the loss of the action potential dome in the right ventricular epicardium, where the transient outward current (Ito) is most prominent, but not in the endocardium, which leads to the development of voltage gradients across the ventricular wall. On the other hand, Di Diego and Antzelevitch showed that global ischemia can also cause a loss of the action potential dome in the right ventricular epicardium leading to ST segment elevation using arterially perfused canine right ventricular wedge preparations. Their experimental data using the Brugada syndrome model induced by terfenadine and acute transmural no-flow ischemia model, suggested that the Ito can modulate the electrocardiographic manifestations of acute ischemia as well as that of Brugada syndrome, probably caused by a similar electrophysiological substrate. In other words, it can be said that the electrocardiographic manifestations of Brugada syndrome are similar to those encountered during ischemia.

In addition, recent reports have suggested that ischemia from the conus branch or right ventricular branch causes Brugada type ST segment changes and the responsible area for those changes is thought to be the right free wall and right ventricular outflow tract.

In our study, as demonstrated in case 1, we also showed that ischemia from the conus branch region provokes Brugada type ST segment changes. In addition, we experienced a case of Brugada type ECG in which Brugada type ST segment changes might have also been enhanced by vasospasms of the conus branch of the right coronary artery.

The possible mechanisms by which the enhancement of the ST segment elevation in the conus lesions occurs might be due to a decrease in the I Ca, caused by Ach or an increase in the ATP sensitive K channels (IK ATP) caused by ischemia. It has been shown that the ST segment elevation is augmented by an intracoronary injection of Ach without any induction of coronary spasms in Brugada syndrome. Therefore, the augmentation of the ST segment elevation in case 2 might be explained by the effect of the Ach itself. On the other hand, ischemia opens the IK ATP and results in a loss of the dome of the action potential. Furthermore, it has recently been demonstrated that reduced Na channel availability in the ventricular epicardium may contribute to its greater sensitivity to electrical depression and thus may contribute to the ST segment changes in acute myocardial ischemia. Therefore, the augmentation of the ST segment elevation in the presence of Ach in case 2 might be explained by a conus branch ischemia-induced electrical depression in the ventricular epicardium in addition to the effect of the Ach itself.

Brugada syndrome and vasospastic angina share similar characteristics, such as the time at which the episodes frequently occur or the response to autonomic modulation. In addition, as described above, Noda, et al reported that ST-segment elevation was augmented by 11 of 33 right coronary injections of Ach and/or ergonovine maleate in patients with Brugada syndrome, providing the hypothesis that mild ischemia and vagal influences act additively or synergistically with the substrate responsible for the Brugada syndrome to elevate the ST segment and precipitate VF. On the other hand, a recent report presented a case with Brugada syndrome and vasospastic angina in which shortening of the ventricular fibrillatory intervals after the administration of a Ca channel blocker, verapamil, which is expected to augment the voltage gradient between the epicardium and endocardium, was observed.

Thus, it can be said that Brugada syndrome and vasospastic angina might share similar modification factors such as autonomic modulation, responsiveness to beta blockers, and possibly ST segment augmentation by ischemia and vagal influences, whereas some differences such as the response to Ca channel antagonists might exist. Hence, we should take special caution in the treatment of patients who present with the possible coexistence of Brugada syndrome and vasospastic angina.

In summary, the present findings suggest that the free wall of the right ventricular outflow tract supplied by the conus and right ventricular branches plays a pivotal role in the genesis of Brugada type ECG changes and ischemia from conus branch lesions, which may cause voltage gradients across the right ventricular wall, also contributes to the augmentation of the Brugada type segment changes.
REFERENCES


