Paroxysmal Supraventricular Tachycardia with QRS Duration Alternans, Electrical Alternans, and Pulsus Alternans but without Cycle Length Alternans

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We reported a 60-year-old male patient who had a paroxysmal supraventricular tachycardia with QRS duration alternans (alternation between narrow QRS and wide QRS beats) and electrical alternans, but without any cycle length alternans. In the laboratory, slow-fast atrioventricular nodal reentrant tachycardia was easily induced by an atrial extrastimulus, and the arterial pressure recordings displayed a simultaneous pulsus alternans during tachycardia. The patient also underwent coronary angiography which revealed a total occlusion of the left anterior descending artery. In this report, we have proposed that the QRS duration alternans, electrical alternans and pulsus alternans during the paroxysmal supraventricular tachycardia may have been due to the prolongation of the effective refractory period of the right bundle branch, caused by myocardial ischemia.

Key Words: Electrical alternans • Myocardial ischemia • Supraventricular tachycardia

INTRODUCTION

QRS duration alternans is a sign of QRS duration oscillation beat by beat. It is a rare clinical condition, and frequently associated with paroxysmal supraventricular tachycardia (PSVT). The nature of the definitive underlying mechanism is still unclear, but it was most often noted during atrioventricular reciprocating tachycardia with two distinct antegrade conduction pathways. Therefore, the QRS alternans during PSVT is commonly associated with cycle length alternans. Clinically, pulsus alternans is most often noted in the condition of left ventricular systolic failure. In addition, electrical alternans is defined as alternation of the amplitude of QRS complex. The most common cause for electrical alternans is pericardial effusion. The functional swings of the heart make the amplitude of QRS complex change. However, myocardial ischemia would cause both phenomena.

We herein presented a case of PSVT with QRS duration alternans, but without cycle length alternans. The findings of pulsus alternans and electrical alternans were noted simultaneously, so myocardial ischemia was suspected as the cause of the above findings. Coronary angiography also confirmed our suspicion. To our knowledge, this is the first case report for such conditions, and the possible etiology is myocardial ischemia.

CASE REPORT

A 60-year-old man was sent to the emergency department twice in 10 days due to a sudden onset of palpitations and chest tightness. His physical examination revealed a heart rate of 140 bpm and the 12-lead ECG (Figure 1A) showed a paroxysmal supraventricular...
tachycardia (PSVT) with QRS duration alternans (alternation between narrow QRS and wide QRS beats) and electrical alternans, but without any cycle length alternans. The symptoms and heart rate resolved after an intravenous bolus of 6 mg of adenosine. The patient was referred to our clinic for further evaluation and management. Later echocardiographic imaging showed no evidence of hypertrophic cardiomyopathy. The patient performed a treadmill exercise test for a duration of 6 minutes, which revealed ST depression of more than 1 mm in the inferior leads. He then underwent coronary angiography and an electrophysiologic (EP) study plus catheter ablation. Review of the coronary angiography revealed a total occlusion of the left anterior descending (LAD) artery (arrowhead) (Figure 1B). In the laboratory, slow-fast atrioventricular nodal reentrant tachycardia (AVNRT) was easily induced by atrial extrastimulus (Figure 2A). The QRS duration alternans and electrical alternans persisted during each tachycardia episode. The arterial pressure recordings displayed a simultaneous pulsus alternans during the tachycardia (arrow), and the ECG exhibited a wide QRS beat (when bundle branch block occurred) after the occurrence of a lower arterial pressure (Figure 2A). After delivering a premature ventricular beat, the QRS duration alternans and pulsus alternans persisted, but the ECG exhibited a wide

![Figure 1](image1.png)

**Figure 1.** (A) A 12-lead ECG revealing paroxysmal supraventricular tachycardia with QRS duration alternans (alternation between narrow QRS and wide QRS beats) and electrical alternans, but without any cycle length alternans. All the wide QRS beats had right bundle branch block morphology except for one ventricular premature beat. (B) A fluoroscopic view of the coronary arteries revealed a chronic total occlusion of the left anterior descending artery (arrowhead) with collateral circulation from the branches.
QRS beat after the occurrence of a higher arterial pressure (Figure 2B). Successful slow AV node modification was done without any complications. There was normal pulse (no pulse alternans) during sinus rhythm before and after ablation. In addition, successful percutaneous coronary intervention of the totally occluded lesion of the LAD artery was performed using a drug-eluting stent during the following admission.

DISCUSSION

Mechanical (pulsus) alternans and electrical alternans are both associated with myocardial ischemia and are not an uncommon phenomenon during PSVT.6-8 However, QRS duration alternans is a rare condition during PSVT, and is frequently associated with a cycle length alternans.9,10 Interestingly, the QRS duration alternans in our case occurred during all PSVT episodes, but without any cycle length alternans. Apparently, the QRS duration alternans was not related to the cycle length alternans, which completely differed from the previous reports. It is amazing that the QRS alternans persisted simultaneous with the pulsus alternans and electrical alternans. A narrow QRS beat was noted after the occurrence of a higher arterial pressure (Figure 2A). We originally proposed that the mechanoelectric feedback (a higher pressure resulted in a shorter action potential duration and effective refractory period) modulated the regional electrophysiologic characteristics in the right bundle branch, and may have been responsible for the generation of the QRS duration alternans.7 However, after delivering a ventricular premature beat, the relationship between the QRS duration alternans and pulsus alternans changed: a wide QRS beat was found after the occurrence of a higher arterial pressure. Therefore, the mechanoelectric feedback could not explain the phenomenon. After reviewing the report from the treadmill exercise test, we found that the right bundle branch block was rate-dependent. It happened when the heart rate became faster than 120 beats per minute. In addition, the blood supply to the right bundle branch was from the septal branch of the LAD artery which was completely blocked in this case. Maybe an anatomic cause (myocardial ischemia) could have resulted in the prolongation of the effective refractory period of the right bundle branch, and could have been responsible for the generation of the QRS duration alternans during the PSVT. As shown in Figure 2B, a weak pulse (low blood pressure) is caused by the VPB because of inadequate venous return. According to the Frank-Starling law, the following beat (after VPB) with a longer ventricular filling time should be a strong pulse (high blood pressure) (Figure 2B). We delivered a ventricular premature beat (VPB) during the supraventricular tachycardia. The QRS duration alternans and pulsus alternans persisted after the VPB, however, the relationship of the two alternans changed: the narrow QRS beat is followed by a lower arterial pressure and the wide QRS beat (with right bundle branch block) is followed by a higher arterial pressure (arrows).
pressure). In addition, the VPB depolarized the right bundle earlier and resulted in the following narrow QRS beat. Therefore, the relationship between two alternans changed. Finally, the patient underwent follow-up treadmill exercise test several months later for evaluating recurrent angina, and rate related bundle branch block was still found.

In conclusion, we reported a case with QRS duration alternans, electrical alternans and pulsus alternans during PSVT episodes but without cycle length alternans. Those alternans may have been due to the total occlusion of the LAD artery.

REFERENCES