Ventricular fibrillation with intracoronary adenosine during fractional flow reserve assessment.

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Ventricular fibrillation with intracoronary adenosine during fractional flow reserve assessment☆

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ABSTRACT

Fractional flow reserve (FFR) measurement provides useful hemodynamic assessment of intermediate coronary stenoses affecting long term outcomes. While the gold standard remains intravenous adenosine, intracoronary (IC) bolus administration of adenosine is routinely used in clinical practice because of its ease of use and lower dose providing comparative hyperemia with the most common side effect being a transient atrioventricular block. A 62 year old male underwent left heart catheterization after ruling in for non-ST elevation myocardial infarction (NSTEMI). Presenting electrocardiogram (ECG) showed an old left bundle branch block and T-wave inversions in lateral leads (QTc 494 ms) with no significant electrolyte abnormalities. Coronary angiography revealed an intermediate lesion in mid left anterior descending coronary artery. FFR assessment with IC adenosine (24 μg/mL of normal saline) was performed inducing ventricular fibrillation (VF). He was successfully defibrillated with a single 200 J shock and no further arrhythmias were noticed during rest of his hospital stay.

1. Introduction

FFR assessment is an increasingly utilized tool in cardiac catheterization laboratories which provides useful hemodynamic assessment of intermediate coronary stenoses affecting long term outcomes [1]. While the gold standard remains intravenous adenosine administration, IC bolus administration of adenosine is routinely used in clinical practice because of its ease of use, lower dose, and hence, overall cost. Recent data suggest that higher doses of IC adenosine could be as efficient as intravenous adenosine in obtaining maximum hyperemia and are considered to be relatively safe and well tolerated. We present a case of VF induced by IC adenosine during FFR assessment.

2. Case report

A 62-year-old male with significant history of active smoking over 25 years, peripheral arterial disease, cerebrovascular accident, hypertension and hyperlipidemia presented to emergency department with an acute worsening of intermittent exertional chest pressure radiating to left arm for a month and associated shortness of breath. His chest pain resolved upon arrival after chewable aspirin 324 mg and a single dose of 0.4 mg sublingual nitroglycerine. Blood pressure on presentation was 140/73 mmHg with a pulse of 70 bpm. He was euvolemic on physical examination and presenting ECG showed an old LBBB and T-wave inversions in lateral leads with a QTc interval of 494 ms and QRS duration of 136 ms (Fig. 1). Pertinent admission laboratory data include a K^+ of 3.6 mmol/L (3.6 mEq/L), Mg of 0.78 mmol/L (1.9 mg/dL), NT-proBNP of 3254 ng/L and initial Troponin-I of <0.01 μg/L. He ruled in for a NSTEMI with a repeat Troponin-I of 0.7 μg/L and was started on intravenous heparin infusion along with a high intensity statin and a beta-blocker. Coronary angiography revealed a normal left main with mild non-obstructive disease in left circumflex and right coronary arteries. There were two lesions in the mid segment of the LAD, up to maximum 50% stenosis in multiple views (Fig. 2). To assess their physiologic significance, FFR measurement was performed. Baseline FFR assessment decreased from 0.99 to 0.92 following administration of 72 μg (24 μg/mL of normal saline) of IC adenosine. In order to ensure maximal hyperemic response of the coronary bed, an additional 96 μg of IC adenosine was administered after two minutes, followed by fast normal saline flush.

Abbreviations: ECG, Electrocardiogram; FFR, Fractional Flow Reserve; IC, Intracoronary; LAD, Left Anterior Descending Coronary Artery; LBBB, left bundle branch block; NSTEMI, Non ST-segment Elevation Myocardial Infarction; VF, Ventricular Fibrillation; VT, Ventricular Tachycardia.

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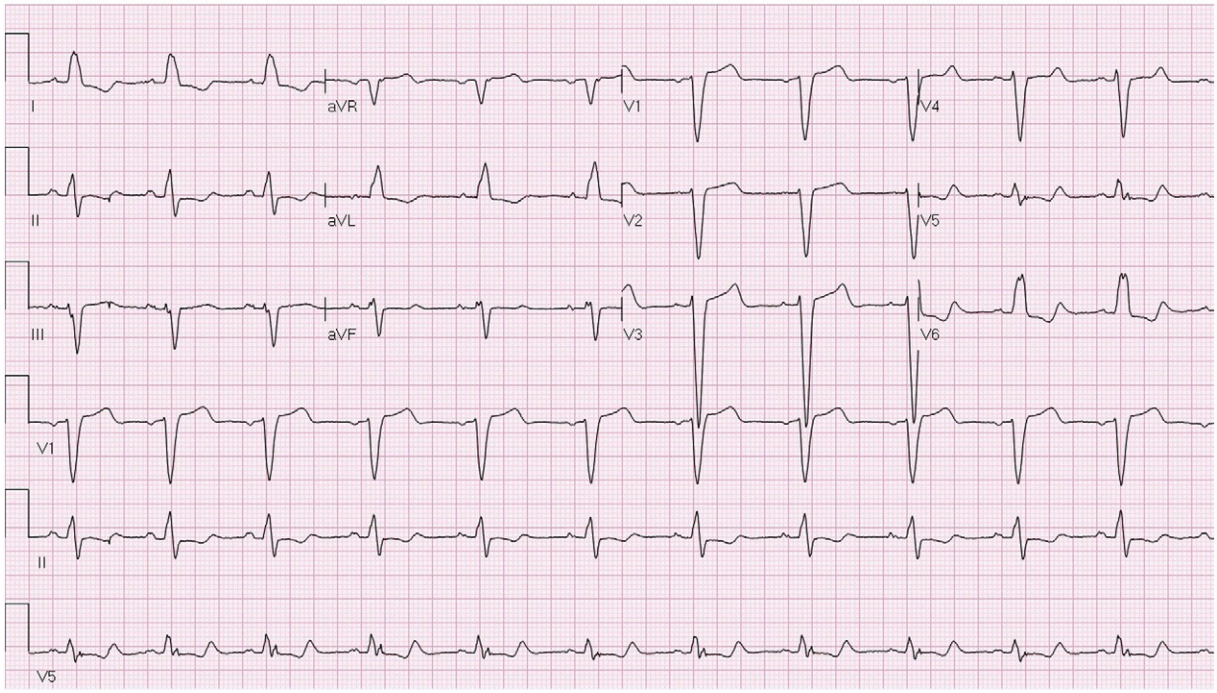

Fig. 1. Presenting ECG showing normal sinus rhythm with LBBB.

The patient went into polymorphic VT, degenerating into coarse VF immediately following the saline flush (Fig. 3). He was successfully defibrillated with a single 200 J shock and remained hemodynamically stable for the rest of the procedure. Transthoracic echocardiogram obtained after the procedure showed moderately depressed left ventricular ejection fraction with global hypokinesis and no significant valvular abnormalities. No further arrhythmias were noticed for the remainder of his hospital stay.

3. Discussion

Adenosine has long been utilized for treatment and identification of supraventricular tachycardias and during electrophysiology studies to induce ectopy. It is generally considered a safe drug owing to its short half-life. Adenosine has variable mechanisms of action on peripheral and coronary circulation and myocardium. It results in shortening of atrial action potentials, reducing the effective refractory period resulting in a temporary atrioventricular block [2]. In addition, adenosine causes a reflex increase in circulating catecholamine levels which occasionally results in rebound sinus tachycardia and atrial or ventricular ectopy that may provoke re-initiation of reentrant tachyarrhythmias [3]. However, transient bradyarrhythmias remain the more common proaarhythmic effects of intravenous adenosine and the data regarding sustained ventricular dysrhythmias remain scarce [4].

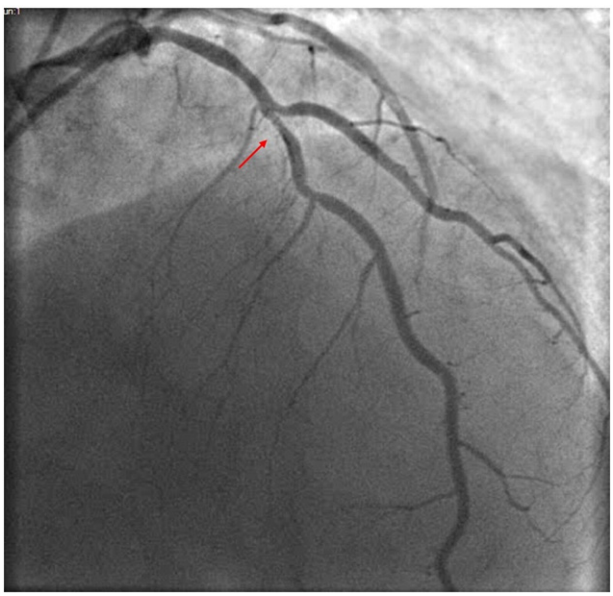

Fig. 2. Mid LAD lesion *(arrow)* which was assessed by intracoronary FFR.

FFR assessment utilizes adenosine's endothelium dependent vasodilatory effects on peripheral and coronary circulation. Although intravenous and intracoronary injections are thought to be comparable [5], there is still no clear consensus on a minimum effective, safe IC adenosine dose and concentration required for FFR assessment [6]. IC adenosine is generally well tolerated with the most common side effect being a transient atrioventricular block seen with high doses [7]. Shah et al. for the first time reported a case series of three patients who developed VF following administration of IC adenosine [8]. Unlike our case where VF was precipitated by much smaller and more concentrated dose of IC adenosine, all three patients in their case series received at least 360 μg (12 μg/mL of normal saline) boluses of IC adenosine during FFR assessment of LAD or left circumflex arteries. Although baseline ECG characteristics were not reported by Shah et al., to our knowledge, this is the first case of IC adenosine induced VF with a more routinely used concentration with a much smaller dose concentration and in the presence of existing LBBB.

Considering sustained VT/VF to be a life threatening arrhythmia, it is important to recognize risk factors like electrolyte derangements that may predispose patients to this during routine FFR assessments. Presence of prolonged QT interval on ECG should also prompt careful review of patient's prior history and medications which may interact with adenosine. Bundle branch blocks prolong QT interval and pose a common clinical problem in assessing the intrinsic QTc interval [9]. Baseline bundle branch block or prolonged QT interval did not predict development of malignant arrhythmias during FFR assessment through IC papaverine in a cohort reported by Nakayama et al [10]. Shah et al. have proposed that volume of intracoronary injection (adenosine plus saline mix), may displace coronary blood for a few seconds contributing to development of VF and report no new cases of IC adenosine induced VF

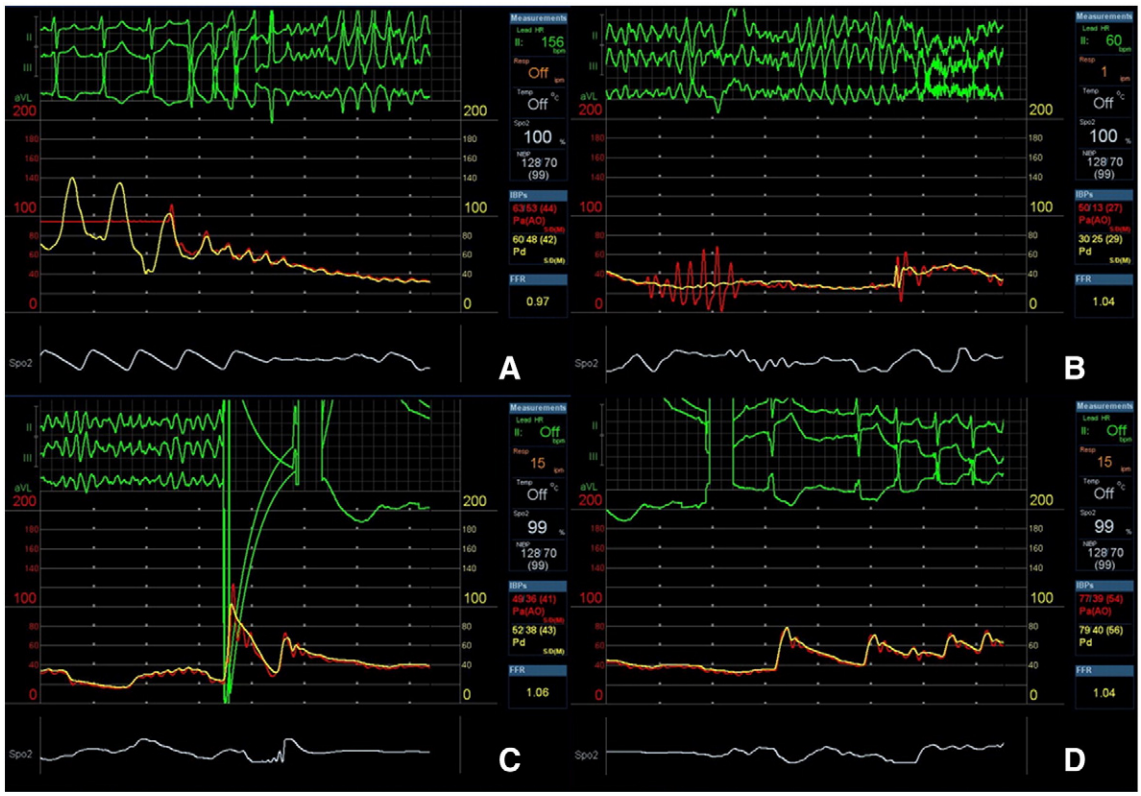

Fig. 3. Degeneration of normal sinus rhythm to polymorphic VT **(Panel A)** and later ventricular fibrillation **(Panel B)** following 96 μg (concentration, 24 μg/mL of normal saline) of intracoronary adenosine and successful defibrillation with 200 J ×1 **(Panels C & D)**.

since doubling of dilution concentration in their practice [8]. This hypothesis may partially be responsible, considering old experience of optical coherence tomography (OCT) where 5/468 (1.1%) patients suffered VF with a mean volume of intracoronary contrast injected of 36.6 ± 9.4 ml [11]. Similarly, in our case, although IC adenosine injection was more concentrated (24 μg/mL of saline), it was immediately followed by 15 cm^3 of normal saline bolus, which would have led to higher bolus volume injection at one time. This may not be the sole reason; underlying LBBB with pseudo prolongation of QTc may have played a role as well, especially in the presence of deranged electrolytes.

4. Conclusion

FFR assessment has become the benchmark of guiding revascularization therapy for intermediate coronary lesions and more routinely used than before. It is important to recognize potential complications and side effects associated with IC adenosine. Furthermore, cardiac catheterization labs should be equipped and have protocols delineated to handle such life threatening emergencies.

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