Case Report

THE SHARK FIN PATTERN AS A PREDICTOR OF SUDDEN CARDIAC DEATH IN ISCHEMIC AND NON-ISCHEMIC PATIENTS

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ABSTRACT

Background: The "shark fin" pattern, also known as a triangular QRS–ST–T waveform, is a distinctive electrocardiographic (ECG) manifestation of ST-segment elevation myocardial infarction (STEMI). It is characterized by a triangular morphology resulting from the fusion of the QRS complex, ST segment, and T wave.
Case Illustration: We present a case series of three patients exhibiting the "shark fin" ECG pattern. Two patients were adults with a history of ischemic heart disease, while one was a 19-year-old male with no significant past medical history. One adult patient was treated with thrombolytic therapy, and the other underwent percutaneous coronary intervention. One of the adult patients and the young patient developed malignant arrhythmias and subsequently experienced sudden cardiac death.
Conclusion: The "shark fin" ECG pattern is associated with a poor in-hospital prognosis, including an increased risk of ventricular fibrillation (VF) and sudden cardiac death (SCD) in both ischemic and non-ischemic patients. When this pattern is identified, prompt and aggressive management is essential to improve patient survival.

Keywords: Shark fin; Ventricular fibrillation; Cardiogenic shock: sudden cardiac death

INTRODUCTION

The ST-segment elevation myocardial infarction (STEMI) is a very serious type of acute coronary syndrome or heart attack in which transmural myocardial ischemia due to occlusion of the coronary artery results in myocardial injury or necrosis. This electrocardiographic hallmark which typically characterized by J-point elevation was first described in 1920 by Pardee and has been known for a century. This pattern may have different morphology, duration, and polarity of the T wave depending on the location, severity, and duration of the ischemia. The most notorious of STEMI patterns is the tombstoning which showed a domed ST-segment configuration resembling a tombstone. Previous studies reported a specific "shark fin" pattern characterized by a triangular giant wave (amplitude > 1 mV) resulting from the fusion of QRS complex, steep down-sloping ST-segment,

and T wave with positive polarity.1 The “shark fin” pattern is a relatively new term; it was previously referred to as lambda-like pattern and giant R wave but the terminology triangular QRS-ST-T waveform has been suggested.[1] The “shark fin” pattern was associated with malignant in-hospital prognosis, increased risk of ventricular fibrillation (VF) on admission, the involvement of left main coronary artery (LMCA), and sudden cardiac death (SDC) due to cardiogenic shock in STEMI patients and rare cases of Takotsubo cardiomyopathy (Cipriani, 2018; Tarantino, 2018). We present three cases of patients with the “shark fin” ECG pattern to warn us that this ECG patten can have dangerous outcome in both ischemic and non-ischemic patient if not recognized and treated promptly.

CASE ILLUSTRATION

Case 1

A 48-year-old female patient complained of chest discomfort, shortness of breath, and dizziness before being admitted to the emergency room. She has a past medical history of hypertension, diabetes, and ischemic stroke 8 years ago. On admission, she was unconscious, without arterial pulse and her admission ECG showed VF. CPR and defibrillation were performed and ROSC was achieved afterward. Endotracheal intubation was carried out, and 12-lead ECG showed Triangular QRS-ST-T waveform (“shark fin” pattern) at inferior leads. Laboratory findings showed leukocytosis ($20.7*10^3/\mu L$), elevated liver enzyme (SGOT 340 U/L, SGPT 314 U/L), decreased kidney function (Cr 1.6 mg/dl, eGFR 37.57ml/min/1.73 m^2), hyperglycemia (794 mg/dL), and normal sodium (137 mmol/L) and potassium (3.5 mmol/L). Coronary angiography revealed 3 vessel disease (VD) with total occlusion of proximal RCA, 60-80% stenosis of proximal LCX, diffuse 60-90% stenosis of proximal to distal LAD, and diffuse 80-90% stenosis of Ramus Intermedius. Primary PCI was performed, and a drug-eluting stent (DES) was implanted on the culprit lesion of RCA. The patient has recurrent VF during the procedure, hence 200-joule defibrillation was done about 7 times, and an IV drip of amiodarone and norepinephrine was also administered. After the procedure, the patient was still unconscious and unresponsive with hyperglycemia (600 mg/dL). Blood gas analysis showed slight compensated respiratory alkalosis (pH 7.47, pCO_2 27.8, HCO_3 20.0) with good arterial oxygenation (pO_2 99.9). The patient was given aspirin, ticagrelor, statin, and amiodarone, while the insulin drip was administered to lower her glucose level. After two days of treatment, the patient showed no sign of improvement and her condition kept deteriorating. Unfortunately, the patient went to cardiac arrest, CPR failed to revive her, and was pronounced dead on the third day of hospitalization.

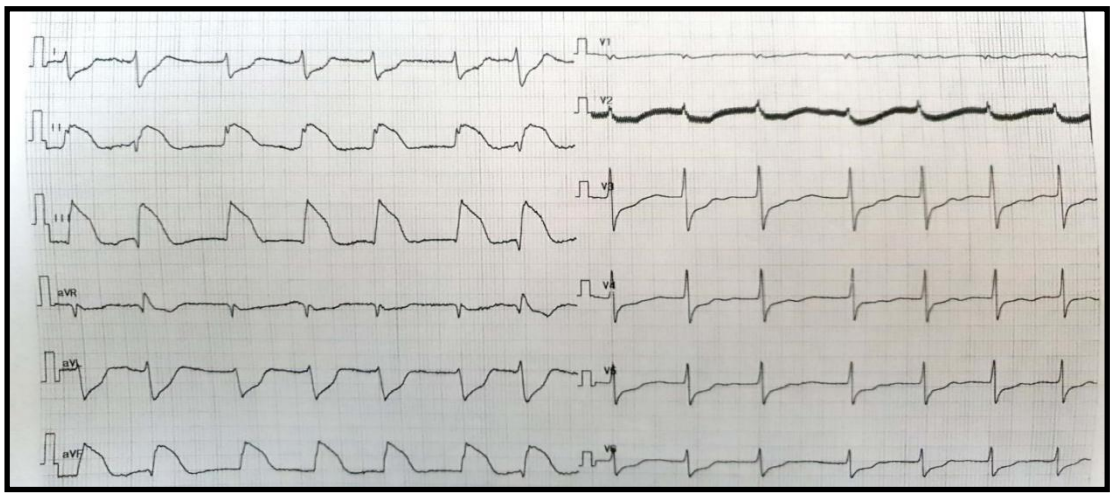

Figure 1. ECG after ROSC showed the "shark fin" pattern on inferior leads.

Case 2

A 19-year-old male was admitted to the Emergency Department due to seizure about 1 hour ago. His past medical and family history were unremarkable. At presentation, he was unconscious without arterial pulse, and the monitor showed VF. CPR and defibrillation about seven times terminated VF. ROSC was achieved with blood pressure 96/53 and heart rate 88bpm. Tracheal intubation, intravenous fluid resuscitation, and vasopressor were attempted. Later, 12-lead ECG showed wide complex QRS with positive dominant R wave resembling "shark fin" at lead aVR. Laboratory showed normal troponin I (0.14) and potassium (4.1). Blood gas analysis showed metabolic acidosis (pH:7.084; HCO_3:11.9; pCO_2:39.3) with arterial hypoxemia (pO_2:77). Unfortunately, the patient's rhythm went asystole and CPR failed to save him.

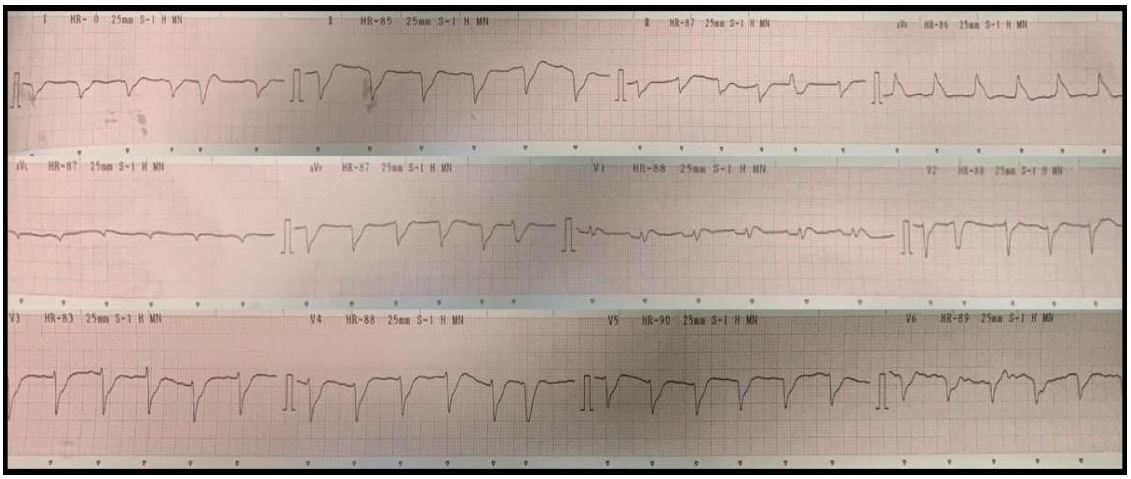

Figure 2. 12 Leads ECG after ROSC Achieved showed the "shark fin" pattern on aVR.

Case 3

A 56-year-old-man was presented to the emergency department with epigastric pain, diaphoresis, and lightheadedness since 3 hours ago. He has a past medical history of hypertension, diabetes, and stroke that occurred 2 years ago. His physical examination showed blood pressure of 80/40 mmHg and heart rate of 70 bpm. A 12-lead electrocardiogram revealed ST-segment elevation at II, III, aVF and Total Atrioventricular block. He was found to have severe hyperkalemia (K 7.1mEq/l), decreased kidney function (Cr 2.7 mg/dl, eGFR 26.15ml/min/1.73 m^2), mild anemia (Hb 12.4g/dl), leukocytosis ($17.3*10^3/\mu L$), mild hyponatremia (128mEq/L) and hyperglycemia (219 mg/dL). A loading dose of aspirin and clopidogrel with nitrate for relieving ischemic discomfort was administrated. Later, the reperfusion strategy for the patient was assessed. He underwent thrombolytic using streptokinase 1,5 million units as there weren't any absolute contraindications. The ECG before thrombolytic showed an evolution of the ST-T segment with Triangular QRS-ST-T wave ("shark fin" pattern) appeared on the inferior leads, Right Bundle Branch Block (RBBB) and first degree AV block.

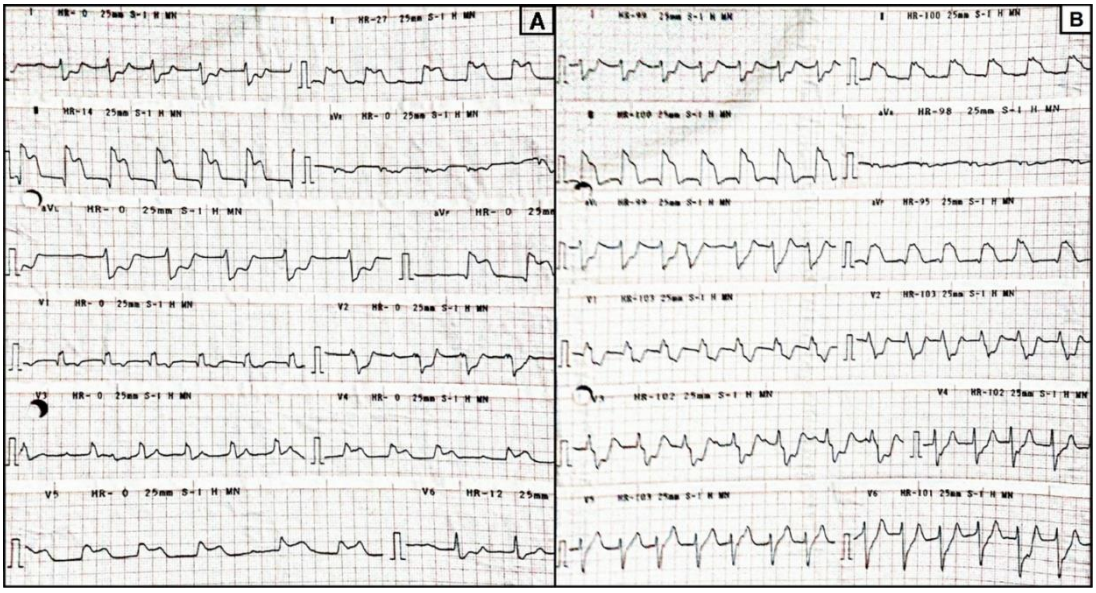

Figure 3. ECG at presentation (A) and before thrombolysis which showed the "shark fin" pattern on the inferior leads (B)

There wasn't any complication following thrombolytic therapy and the patient was monitored in the High Care Unit. More than 50% resolution of ST-segment elevation and terminal T wave inversion at inferior lead suggest the success of thrombolytic therapy. Because of renal impairment, oral hypoglycemic medications were changed to insulin therapy and Enoxaparin was preferred with dose adjustment. Kalium level was normalized to 4.2 mEg/l after using Calcium Polystyrene Sulphonate. Other standard medical managements were also given (nitroglycerin, aspirin, clopidogrel, atorvastatin, Kidmin solution, laxative, benzodiazepine, antibiotic, and proton pump inhibitor). The patient was doing well and discharged from the hospital on the fifth day after thrombolysis. There weren't any malignant arrhythmias events that occurred during hospitalization.

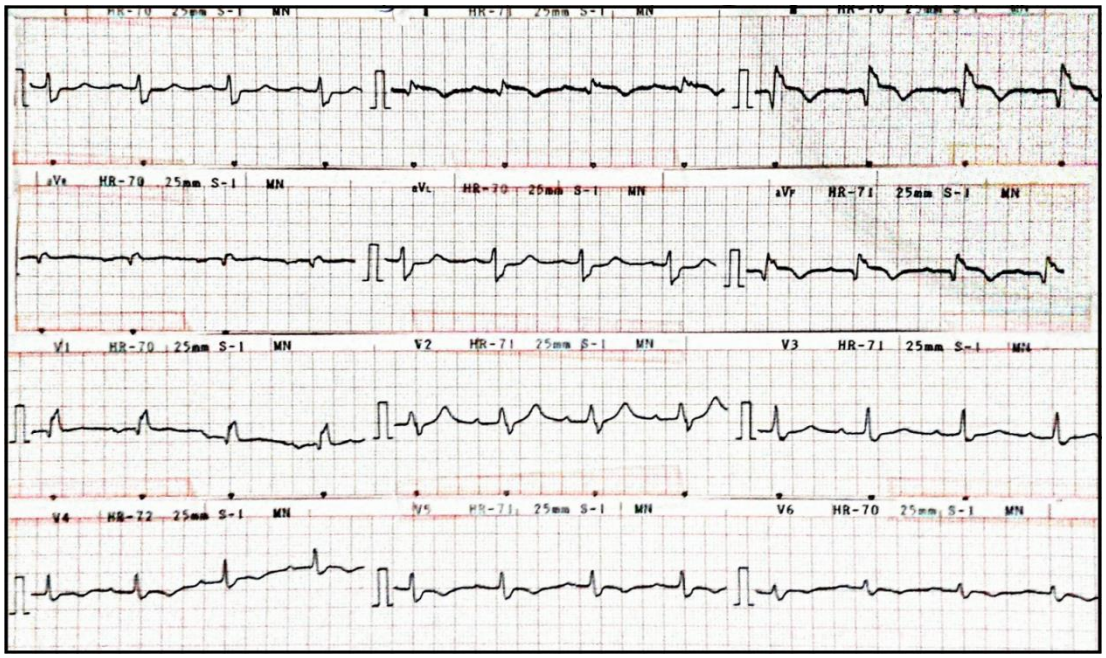

Figure 4. ECG after Thrombolytic

Table 1. Clinical Characteristic of the three patients with "shark fin" ECG pattern.

Patient	Sex, Age (years)	Past Medical History	Clinical presentation	VF	Culprit Vessel	Cardiogenic Shock	Acute Management	Final Outcome
#1	Female, 48	Hypertension, diabetes, stroke	Cardiac arrest (preceded by chest pain, dizziness, and shortness of breath)	Yes	RCA	Yes	CPR, DC Shock, PCI	Death (3rd day)
#2	Male. 19	Unremarkable	Cardiac arrest	Yes	Unknown	No	CPR, DC Shock	Death (1st day)
#3	Male, 56	Hypertension, diabetes, stroke	Epigastric pain, diaphoresis, dizziness, hyperkalemia	No	Unknown	Yes	Thrombolytic	Discharge (5th day)

DISCUSSION

Previous studies reported that the "shark fin" pattern or triangular QRS-ST-T waveform was associated with poor prognosis, increased risk of ventricular arrhythmia most commonly VF, LMCA involvement, and sudden cardiac death (SDC) due to cardiogenic shock in STEMI patients, rare cases of atypical Brugada syndrome, and Takotsubo cardiomyopathy (Cipriani, 2018; Tarantino, 2018; Andres, 2004; Gussak, 2004). We have three patients presented with the "shark fin" pattern. The clinical characteristics of these patients can be seen in Table 1. Two patients were > 45 years old and both had history of hypertension, diabetes, and stroke; while one was only 19 years old with unremarkable past medical history. Only one patient had undergone coronary angiography revealing 3 VD with RCA as the culprit vessel. Two patients experienced one or more episodes of VF at admission. Two patients developed cardiogenic shock. Two of the three patients died. This pattern was rarely found with incidences of only 1.4% among STEMI patients and only 3.2% among Takotsubo cardiomyopathy patients according to studies conducted by Cipriani et al. and Tarantino et al (Cipriani, 2018; Tarantino, 2018). Experimental and clinical studies suggested this pattern as the earliest sign of acute transmural myocardial infarction, and may be transient which might explain its rarity (Ali, 1961); Madias, 1997). Cipriani reported five patients with this pattern out of 367 STEMI patients; all five patients with early presentation (<60 minutes), all patients experienced VF, four developed cardiogenic shock, two with LMCA involvement, and two died (Cipriani, 2018). A case-control study reported that this pattern was more prevalent in STEMI patients complicated by VF (48%) compared with the control group (4.1%).[7] Previous case report by Wang et al. also associated this pattern with ventricular arrhythmia (Wang, 2018).

In this case series, one of two patients that died was particularly unique. While one had ischemic heart disease and risk factors, the other one was very young and had unremarkable past medical history. Ventricular fibrillation causing an abrupt cessation of electrical activity and the sudden death of a young, apparently healthy patient is highly unusual. A similar case of a young patient with atypical Brugada syndrome experiencing SCD was reported by Riera et al (Andres, 2004). A sudden and unexpected cardiac arrest due to complete spontaneous cardiac electrical inexcitability of unknown origin is usually referred to as primary idiopathic cardiac asystole. The primary defect in sodium channels is the most plausible explanation for a complete cessation of the spontaneous electrical activity of the heart due to their pivotal role in cardiac depolarization. Among extracardiac mechanisms, cardioinhibitory parasympathetic discharge to the heart is the most evident (Gussak, 2004). In this case, the SCD might be contributed to a defect of the sodium channels since the SDC was preceded by an episode of VF.

CONCLUSION

The "shark fin" pattern is a rare ECG sign. It's not only associated with malignant in-hospital prognosis, increased risk of VF, and sudden cardiac death in ischemic patients but also in nonischemic

patients. When present, prompt aggressive treatments must be attempted as an endeavor to save the patient.

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