The “Shark” fin Electrocardiogram appearance

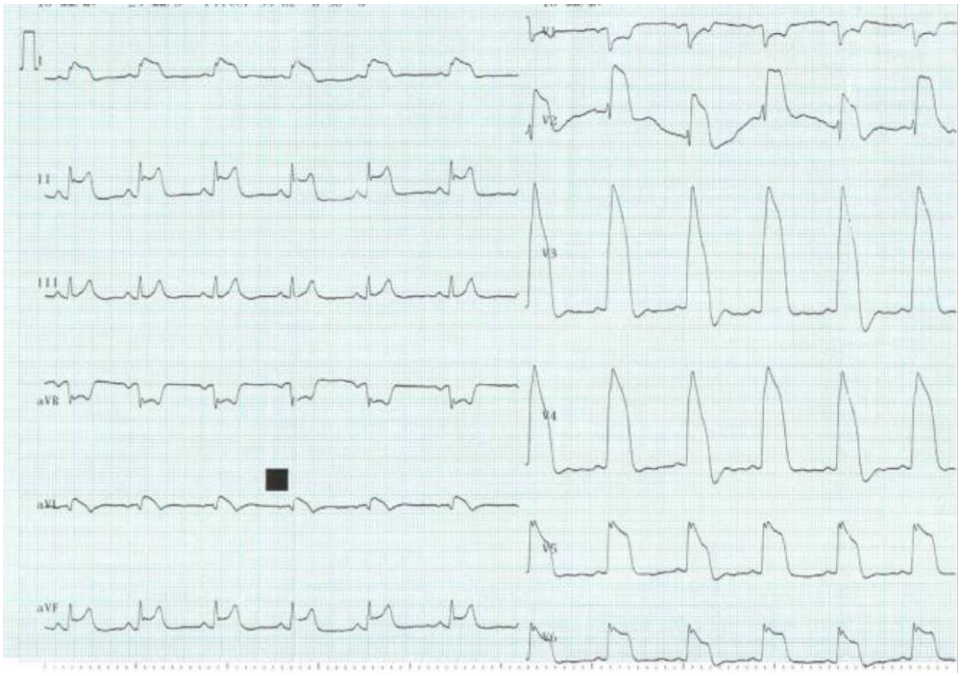
La apariencia electrocardiográfica de "aleta de tiburón"

Examples

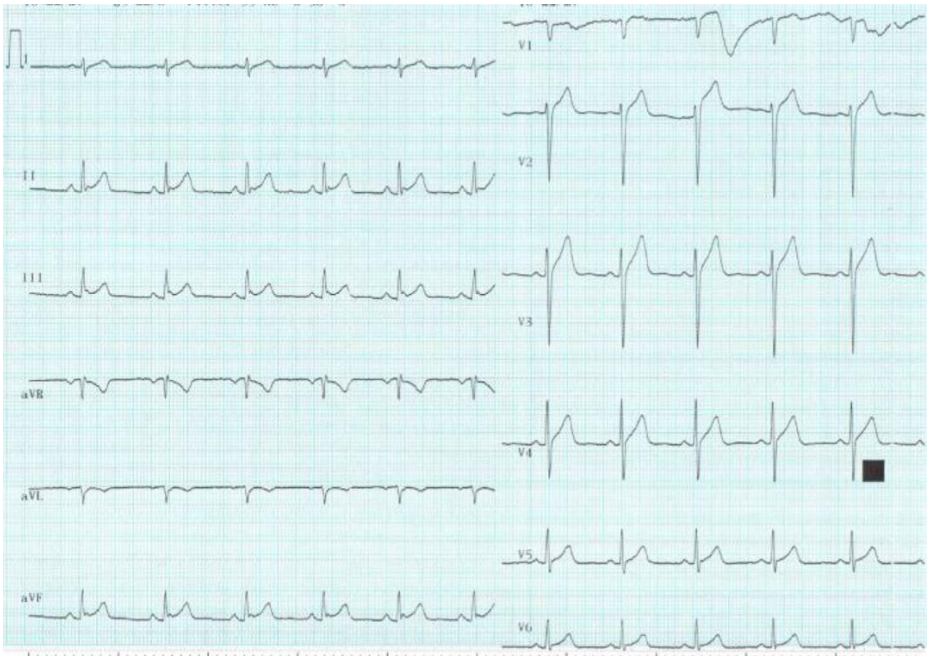
Condition: Prinzmetal’s angina/ coronary spasm/ variant angina ECG showing Shark fin appearance

Characterization: Same as ST-Segment Elevation Myocardial Infarction (STEMI), but transient, increased height of the R wave, S-wave diminution, frequent up sloping TQ in many cases, and alternans of the elevated ST-segment and T-wave inversion (TWI) deepness in 20% of cases, ventricular arrhythmias. The prevalence and importance of ventricular arrhythmias were related to events duration, STE degree, presence of ST-T wave alternans, and higher voltage of R wave (>25%) **(de Luna AB, Cygankiewicz I, Baranchuk A, *et al.* Prinzmetal angina: ECG changes and clinical considerations: a consensus paper. Ann Noninvasive Electrocardiol. 2014;19:442-53. doi: 10.1111/anec.12194**)

Typical ECG example during severe vasospastic angina.



Shark fin appearance caused by fusion of QRS, ST-segment, and T waves, is another high-risk pattern reflecting presence of large area of transmural ischemia and predicting significant mortality.



12-lead ECG immediately after starting IV nitroglycerine showing the diffuse STE returned to baseline.

Left main coronary artery *(LMCA)* "occlusion": a misnomer

STE in aVR with coexistent multi-lead ST depression can be a sign of Non-Occlusion Myocardial Infarction (NOMI) due to severe single or multi-vessel disease, but does not usually represent acute LMCA occlusion as once thought. Such acute occlusion most often causes SCD due to simultaneous anterior, lateral and basal STEMI. This ECG pattern as consistent with LMCA subocclusion or complete occlusion with well-developed collateral circulation.

A 2019 single-centre retrospective analysis identified patients presenting with STE-aVR with multilead ST depression. Coronary occlusion was found only in 10% of patients, and none of these lesions were involving the LAD or LMCA.

1. **Cause of ST elevation (STE) in aVR** There are two possible mechanisms as cause of STE in aVR:

   a) **Diffuse subendocardial ischaemia**, with ST segment depression (STD) in the lateral leads causing reciprocal change in aVR (most common)

   b) **Infarction of the basal septum**, i.e. a STEMI involving aVR. *The basal septum is supplied by the first septal perforator branch (a very proximal branch of the LAD), so ischemia / infarction of the basal septum would imply involvement of the proximal LAD.*

   1. Severe triple coronary vessel disease (TVD) is a severe type of coronary artery disease (CAD) since it involves significant stenosis in any 3 of the major epicardial coronary arteries (i.e., the Right Coronary artery(RCA), Left anterior descending (LAD), and left circumflex (LCx).

      Determinants of in-hospital death in acute myocardial infarction (AMI) with TVD are shock status on admission, the LAD as the infarct related artery (IRA), and serum albumin on admission are significantly associated with in-hospital death in AMI patients with Triple vessel disease (TVD). (***Watanabe Y, Sakakura K, Taniguchi Y, Adachi Y, Noguchi M, Akashi N, Wada H, Momomura SI, Fujita H.*** Determinants of In-Hospital Death in Acute Myocardial Infarction With Triple Vessel Disease. ***Int Heart J . 2016 Dec 2;57(6):697-704. doi: 10.1536/ihj.16-170****.)*

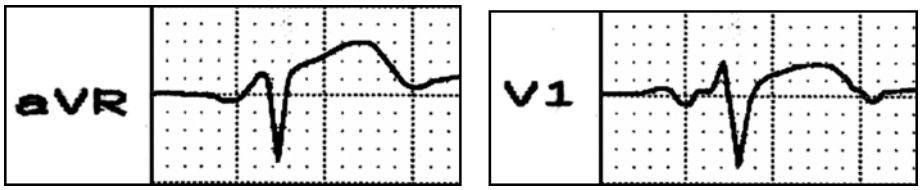
2. Hypoxia or hypotension, for example following resuscitation from cardiac arrest

    I) T-wave positivity in lead aVR

STD in numerous leads: The presence of diffuse STD with STE in aVR is a sign of circumferential ischemia in the setting of ACS. It suggests LMCA, left main-equivalent, or three-vessel disease.

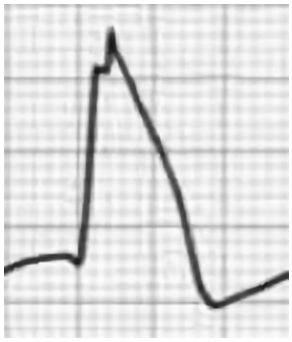
STD in II but not in III and aVF because the injury vector moves away from +60° (II) (Figure).

STE in lead aVR ≥V1 (Figure)



'Shark-fin' sign, "giant R wave", (**Madias JE. The "giant R waves" ECG pattern of hyperacute phase of myocardial infarction. A case report. J Electrocardiol. 1993;26:77-82. doi: 10.1016/0022-0736(93)90068-o**) "lambda-like ST" (**Kukla P, Jastrzebski M, Sacha J, Bryniarski L. Lambda-like ST segment elevation in acute myocardial infarction - a new risk marker for ventricular fibrillation? Three case reports. Kardiol Pol. 2008;66:873-7; discussion 77-8.)or transient triangular QRS-ST-T waveform**)(**Cipriani A, D'Amico G, Brunello G, *et al.* The electrocardiographic "triangular QRS-ST-T waveform" pattern in patients with ST-segment elevation myocardial infarction: Incidence, pathophysiology and clinical**

implications. J Electrocardiol. 2018;51:8-14. doi: 10.1016/j.jelectrocard.2017.08.023) **(Miranda JM, de Oliveira WS, de Sa VP, de Sa IF, Neto NO. Transient triangular QRS-ST-T waveform with good outcome in a patient with left main coronary artery stenosis: A case report. J Electrocardiol. 2019; 54:87-89. doi: 10.1016/j.jelectrocard.2019.02.002**) (Figure)



The literature on this distinct ECG phenomenon is scant, consisting essentially of case reports. Therefore, its incidence is unknown. Presumably many cases go unrecognized and are mistaken for conduction abnormalities, metabolic derangements, or toxicological insult. From the cases that have been described, Shark Fin appears to be an ominous sign with a strikingly poor prognosis.

Other high-risk signs

New RBBB

Myocardial infarction on previous LBBB using Scarbossa criteria:

- STE ≥ 1 mm in the lead with concordant QRS complex--a score of **5 points**.
- STD ≥1 mm in lead V1, V2 or V3--a score of **3 points**.

- STE ≥5 mm in the lead with discordant QRS complex--a score of **2 points**.

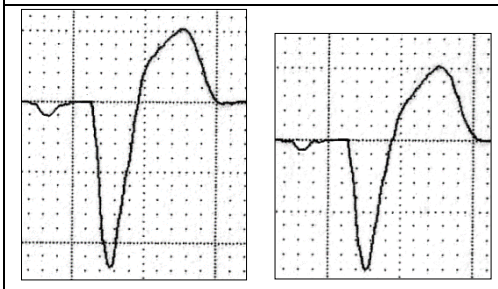
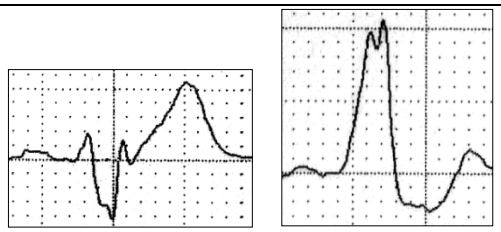
Enumeration of the criteria by Sgarbossa et al, for the diagnosis of LBBB associated to AMI. In the Sgarbossa study, the clinical prediction rule score values of these signs were 5; 3; and 2, respectively. A score ≥3 made a diagnosis of AMI with a 90% specificity and a score of 2 with >80% specificity.

Sgarbossa Electrocardiogram Criteria for the Diagnosis of MI in the Presence of LBBB (Tabas JA, Rodriguez RM, Seligman HK, Goldschlager NF. Electrocardiographic criteria for detecting acute myocardial infarction in patients with left bundle branch block: a meta-analysis. *Ann Emerg Med* 2008;52:329-336.e1; Neeland IJ, Kontos MC, de Lemos JA. Evolving considerations in the management of patients with left bundle branch block and suspected myocardial infarction. *J Am Coll Cardiol* 2012;60:96-105)

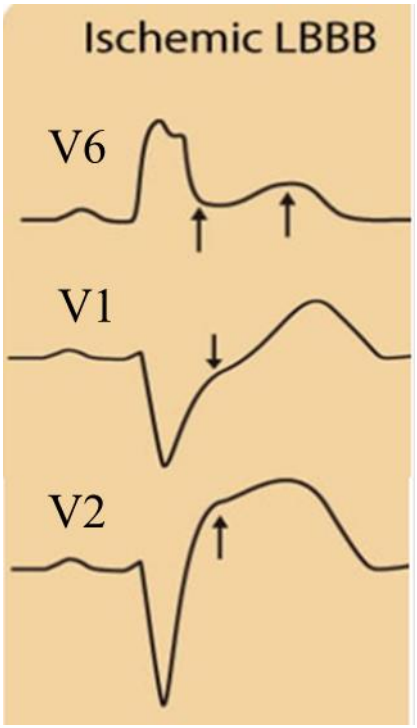
ECG criteria	Assigned point value	Sensitivity %	Specificity %	Positive likelihood	Negative likelihood
STE ≥1 mm and in the same direction with the respective QRS complex	5 points	20% (18-23%)	98% (97-99%)	7.9(4.5 – 13.8)	0.81(0.78-085)
STD ≥1 mm in lead V_1, V_2, or V_3	3 points				

STE ≥5 mm and in the opposite direction with the QRS complex	2 points	41% (37-45%)	85% (82-88%)	2.0 (4.5 – 1.1 3.8)	0.81(0.67-099)

Normal ECG pattern in the right (V1-V2) and left (V5-V6) precordial leads in uncomplicated LBBB

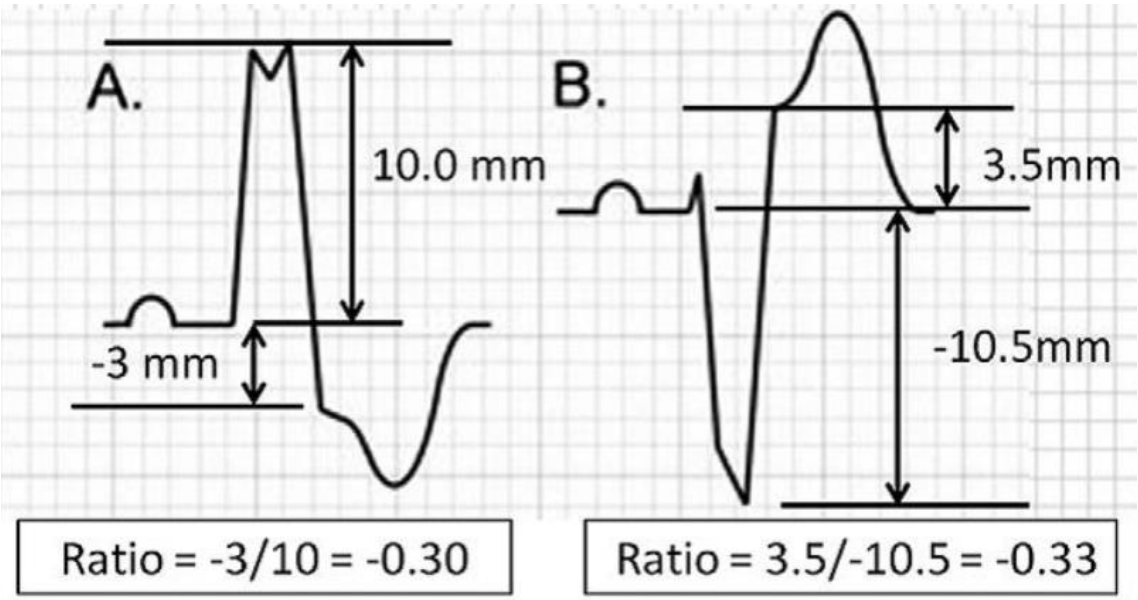
Right precordial leads	Left precordial leads
 **V1** **V2**	 **V5** **V6**

LBBB complicated with AMI



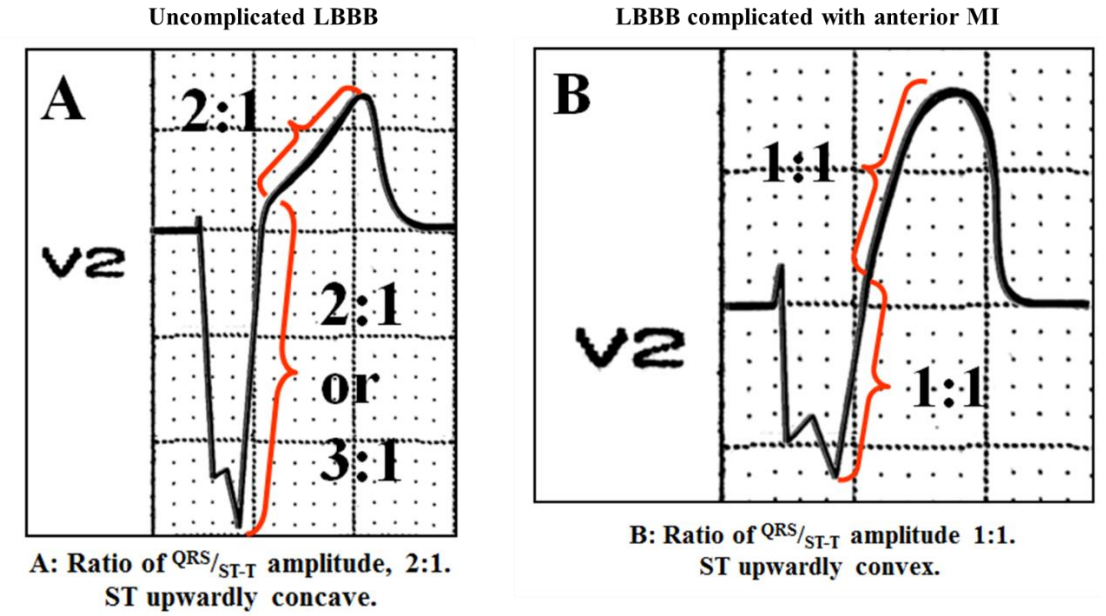
Smith et al.(**Smith SW, Dodd KW, Henry TD, Dvorak DM, Pearce LA. Diagnosis of ST-elevation myocardial infarction in the presence of left bundle branch block with the ST-elevation to S-wave ratio in a modified Sgarbossa rule.** ***Ann Emerg Med*** **2012;60:766-76**.) In order to improve diagnostic accuracy, developed the "modified Sgarbossa criteria," in which the original absolute 5 mm criterion is replaced with a proportion: ST elevation/S-wave amplitude of ≤ -0.25). Smith et al have modified the criteria to improve sensitivity. Smith, et al reported a new rule to replace the 3rd Sgarbossa criterion with the ST-segment elevation to S-wave depth (ST/S ratio): **excessive relative discordance exists if the ST/S ratio is less than -0.25.** This modified Sgarbossa rule increased sensitivity of the test to 91%, although specificity dropped to 90% when using the "weighted rule" (Sgarbossa >3) The authors reported improved diagnostic sensitivity from 52 to 91% in identifying angiographically proven MI but with reduced specificity compared with the original Sgarbossa criteria (90 vs. 98%). (**Larson DM, Menssen KM, Sharkey SW, et al. "False-positive" cardiac catheterization laboratory activation among patients with suspected ST-segment elevation myocardial infarction.** ***JAMA*** **2007;298:2754-60.**). It has yet to be validated, and has not been widely adopted into general practice. The authors reported improved diagnostic sensitivity from 52 to 91% in identifying angiographically proven MI but with reduced

specificity compared with the original Sgarbossa criteria (90 vs. 98%). The modified Sgarbossa criteria have subsequently been validated in a separate cohort(**Meyers HP, Limkakeng AT Jr, Jaffa EJ, et al. Validation of the modified Sgarbossa criteria for acute coronary occlusion in the setting of left bundle branch block: A retrospective case-control study. *Am Heart J* 2015;170(6):1255-64.doi: 10.1016/j.ahj.2015.09.005**).



Abnormal, excessive discordance, with the ST segment and T wave in the opposite direction from QRS. Method of measurement: ST segment is measured at the J point, relative to the PR segment. R wave and S wave are also measured relative to the PR segment.

Other ECG criteria in LBBB complicated with AMI

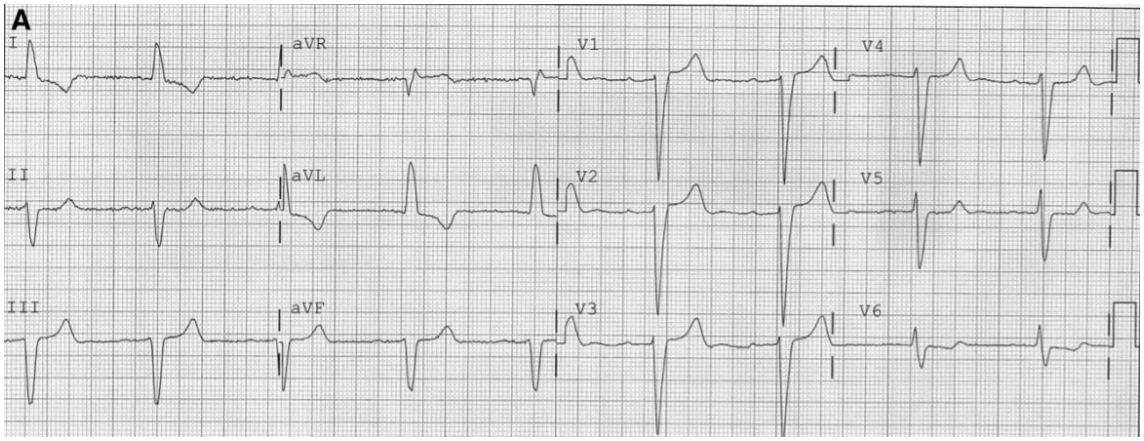


Diminution of $^{QRS}/_{ST-T}$ ratio in lead V2: In uncomplicated LBBB, the ratio of QRS voltage to the ST segment voltage is always greater than 1. Usually 2:1 or 3:1 in V2 lead (**Schamroth L. The Electrocardiology of Coronary Artery Disease. Blackwell Scientific Publications. Oxford London Edinburgh Melbourne. 1975; pg 86.)**

What is already known on this topic Diagnosis of STEMI in the setting of a LBBB is difficult. What question this study addressed Whether changing one component of the Sgarbossa rule from an absolute (5-mm discordant STE) to a proportional criterion (any ST segment to S-wave ratio less than 0.25, with at least 1 mm ST elevation) improves prediction of ACO. What this study adds to our knowledge The revised rule, developed with 162 patients with LBBB, of whom had an ACO, was more accurate than the original rule. It has a positive likelihood ratio of 9 and negative likelihood

ratio of 0.1. How this is relevant to clinical practice? This rule may not be “user friendly” enough for clinicians unless incorporated into ECG machine interpretations and should be validated in a distinct set of ECGs.

Typical ECG example of pseudo LBBB (absence of Strauss criteria)



A, The patient’s baseline ECG with apparent LBBB

Straus criteria: QRS duration 120ms, without notched or slurring in at least two contiguous lateral leads atypical or pseudo LBBB (absence of stricter Straus´s criteria) + LAFB: extreme left axis deviation (QRS axis -45°), SIII>SII, and rS in V_5-V_6. Maximum ST elevation at the J point is 2 mm in lead V2, with an ST/S ratio. Conclusion: pseudo LBBB+ LAFB. ECG from Smith et al.(**Smith SW, Dodd KW, Henry TD, Dvorak DM, Pearce LA. Diagnosis of ST-elevation myocardial infarction in the presence of left bundle branch block with the ST-elevation to S-wave ratio in a modified Sgarbossa rule. *Ann Emerg Med* 2012;60:766-76.**)