

Case Report

South African flag sign facilitating early recognition of acute first diagonal occlusion in a complex non-left main coronary bifurcation lesion: A case report

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Abstract

The South African flag sign is an uncommon electrocardiographic pattern characterized by ST-segment elevation in leads I, aVL, and V2, with reciprocal ST-segment depression in the inferior leads, suggesting acute occlusion of the first diagonal (D1) coronary artery. This case report aimed to highlight the diagnostic value of this sign and describe the intravascular ultrasound (IVUS)-guided management of a complex non-left main coronary bifurcation lesion. A 53-year-old man presented with acute chest pain and diaphoresis of one-hour duration. The electrocardiogram demonstrated the South African flag sign, prompting immediate activation of the ST-segment elevation myocardial infarction protocol. Transthoracic echocardiography revealed anterior and anterolateral wall hypokinesia, with a left ventricular ejection fraction of 54%. Emergency coronary angiography demonstrated 70–80% stenosis of the proximal-to-mid left anterior descending (LAD) artery and complete thrombotic occlusion of the D1 branch, whose ostium was initially obscured. After successful guidewire crossing, a critical 95% ostial D1 stenosis was identified. IVUS was used to assess vessel dimensions and plaque morphology and to guide treatment of the Medina 1-1-1 bifurcation lesion. A provisional one-stent crossover strategy was performed using a drug-eluting stent in the LAD across the D1 bifurcation, followed by proximal optimization, kissing balloon inflation, and repeat proximal optimization. Final angiography showed restoration of coronary flow without significant residual stenosis or procedural complications. The patient remained free of recurrent ischemic symptoms at the two-week follow-up. This case demonstrates that recognition of the South African flag sign can facilitate early localization of D1 occlusion, particularly when the branch ostium is angiographically obscured. IVUS-guided provisional stenting may support procedural planning and optimization in complex non-left main coronary bifurcation lesions.

Keywords: STEMI, South African flag sign, first diagonal artery occlusion, coronary bifurcation lesion, intravascular ultrasound

Introduction

Early identification of the culprit coronary artery in patients presenting with ST-segment elevation myocardial infarction (STEMI) is essential for timely reperfusion therapy and optimal clinical outcomes [1-3]. Although coronary angiography remains the gold standard for identifying



the infarct-related artery, the 12-lead electrocardiogram (ECG) continues to play a pivotal role in predicting the location of coronary occlusion before invasive evaluation [1-3]. Accurate interpretation of ECG findings enables rapid activation of the cardiac catheterization laboratory, facilitates procedural planning, and may reduce door-to-balloon time in patients with acute myocardial infarction [4,5].

Occlusion of the first diagonal (D1) branch of the left anterior descending (LAD) artery is an uncommon cause of STEMI and frequently presents a diagnostic challenge because its ECG manifestations differ from those of more common infarct patterns [6-9]. Unlike proximal LAD occlusion, isolated D1 occlusion typically produces ST-segment elevation in leads I, aVL, and V2 with reciprocal ST-segment depression in the inferior leads [10,11]. This characteristic ECG pattern, known as the South African flag sign, was first described by Littmann as a practical visual aid for recognizing acute high-lateral myocardial infarction caused by D1 occlusion [1]. Despite its distinctive appearance, the South African flag sign remains underrecognized in routine clinical practice, and failure to identify this pattern may delay recognition of the culprit vessel or lead to misdiagnosis as lateral wall myocardial infarction due to left circumflex artery occlusion.

The first diagonal branch (D1) provides blood supply to the anterolateral left ventricular myocardium. Consequently, acute D1 occlusion may result in significant myocardial ischemia, particularly in patients with a dominant or large-caliber diagonal branch. Prompt recognition of the ECG findings and accurate localization of the culprit lesion are therefore crucial for guiding coronary angiography and selecting the optimal revascularization strategy [12-16]. However, coronary intervention in D1 lesions can be technically demanding, especially when the diagonal branch ostium is angiographically obscured by thrombotic occlusion or when complex bifurcation anatomy is present. In such circumstances, intravascular imaging with intravascular ultrasound (IVUS) can provide valuable information regarding vessel size, plaque morphology, lesion characteristics, and stent optimization, thereby improving procedural precision and clinical outcomes [17-21].

Herein, a case of a 53-year-old man presenting with acute STEMI characterized by the classic South African flag sign on ECG is reported. Coronary angiography revealed complete occlusion of the first diagonal branch with an angiographically concealed ostium and a concomitant complex non-left main coronary bifurcation lesion. Successful revascularization was achieved using an IVUS-guided provisional bifurcation percutaneous coronary intervention (PCI) strategy. This case highlights the diagnostic value of recognizing the South African flag sign, illustrates the challenges encountered during complex bifurcation PCI, and emphasizes the complementary roles of careful ECG interpretation and intravascular imaging in optimizing procedural planning and patient outcomes.

Case

A 53-year-old Thai man with a 10-year smoking history presented to the emergency department of the Central Chest Institute of Thailand, Nonthaburi province, Thailand, with acute central chest pain of one-hour duration. The pain was sudden in onset, persistent, and associated with diaphoresis. There was no previous history of coronary artery disease, heart failure, or prior coronary revascularization. On arrival, the patient was hemodynamically stable.

The initial 12-lead ECG demonstrated sinus rhythm with ST-segment elevation in leads I, aVL, and V2, accompanied by reciprocal ST-segment depression in the inferior leads (II, III, and aVF), a characteristic pattern consistent with the South African flag sign, raising suspicion of acute first diagonal (D1) artery occlusion (**Figure 1A** and **Figure 1B**). Based on the ECG findings and the patient's clinical presentation, the STEMI protocol was immediately activated.

Transthoracic echocardiography revealed a left ventricular ejection fraction of 54%, with hypokinesia involving the anterior and anterolateral walls. No significant valvular abnormalities or mechanical complications of myocardial infarction were identified. Initial troponin-T was negative at 11 pg/mL.

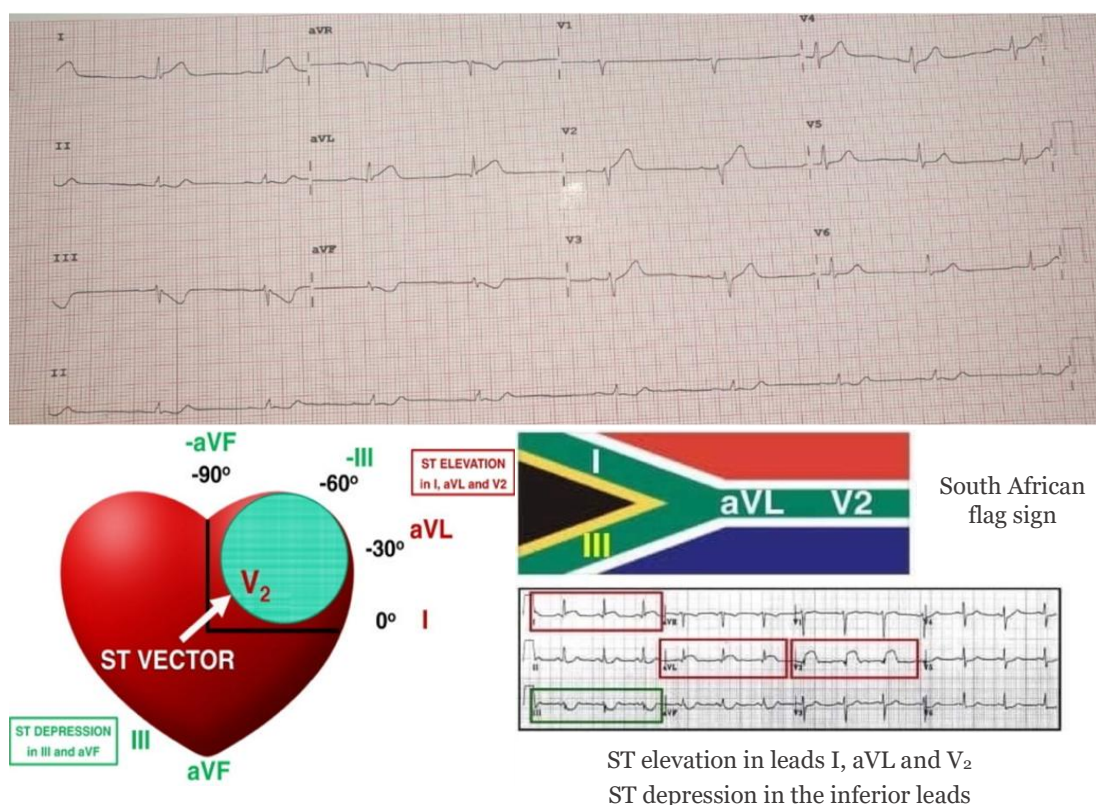


Figure 1. Electrocardiogram (ECG) of the patient and South African flag sign diagram. (A) Twelve-lead ECG demonstrating normal sinus rhythm with ST-segment elevation in leads I, aVL, and V₂, accompanied by reciprocal ST-segment depression in the inferior leads. The ECG pattern is consistent with the South African flag sign, suggesting acute occlusion of the first diagonal branch (D₁). (B) Typical ECG demonstrating the South African flag sign, characterized by ST-segment elevation in leads I, aVL, and V₂ with reciprocal ST-segment depression in the inferior leads, suggesting acute D₁ occlusion.

Emergency coronary angiography was performed via the right femoral artery using standard 7-Fr diagnostic catheters. Angiography demonstrated a severe 70–80% stenosis of the proximal-to-mid LAD artery and complete thrombotic occlusion of the first diagonal (D₁) branch. The D₁ ostium was angiographically obscured by the occlusion. The LAD demonstrated TIMI 3 flow, whereas the D₁ branch demonstrated TIMI 0 flow. The LAD-D₁ bifurcation was classified as Medina 1-1-1 (**Figure 2A**).

Before PCI, the patient received aspirin 325 mg and clopidogrel 300 mg orally. PCI was subsequently performed using a 7-Fr Launcher FL 4.0 guiding catheter. A Runthrough NS Extra Floppy guidewire was advanced into the LAD. Initial attempts to cross the occluded D₁ branch were performed using a SION guidewire. The SION guidewire was successfully advanced across the D₁ occlusion. Subsequent contrast injection demonstrated a critical 95% stenosis at the D₁ ostium, confirming the culprit lesion (**Figure 2B**).

To optimize procedural planning, intravascular ultrasound (IVUS) was performed in both the LAD and D₁ branch. IVUS demonstrated mixed atherosclerotic plaque within the LAD, with distal and proximal reference vessel diameters of approximately 2.75 mm and 3.25 mm, respectively. The D₁ branch measured approximately 2.25 mm in diameter, providing accurate vessel sizing for intervention (**Figure 3**).

Considering the significant LAD stenosis involving the D₁ bifurcation, the critical D₁ ostial lesion, and the overall bifurcation anatomy, an IVUS-guided provisional one-stent crossover strategy was selected. Lesion preparation of the LAD was performed using a 2.5×15 mm semi-compliant balloon inflated up to 12 atm. A 2.75×38 mm zotarolimus-eluting stent was subsequently implanted from the proximal to mid LAD across the D₁ bifurcation, with a maximum implantation pressure of 12 atm.

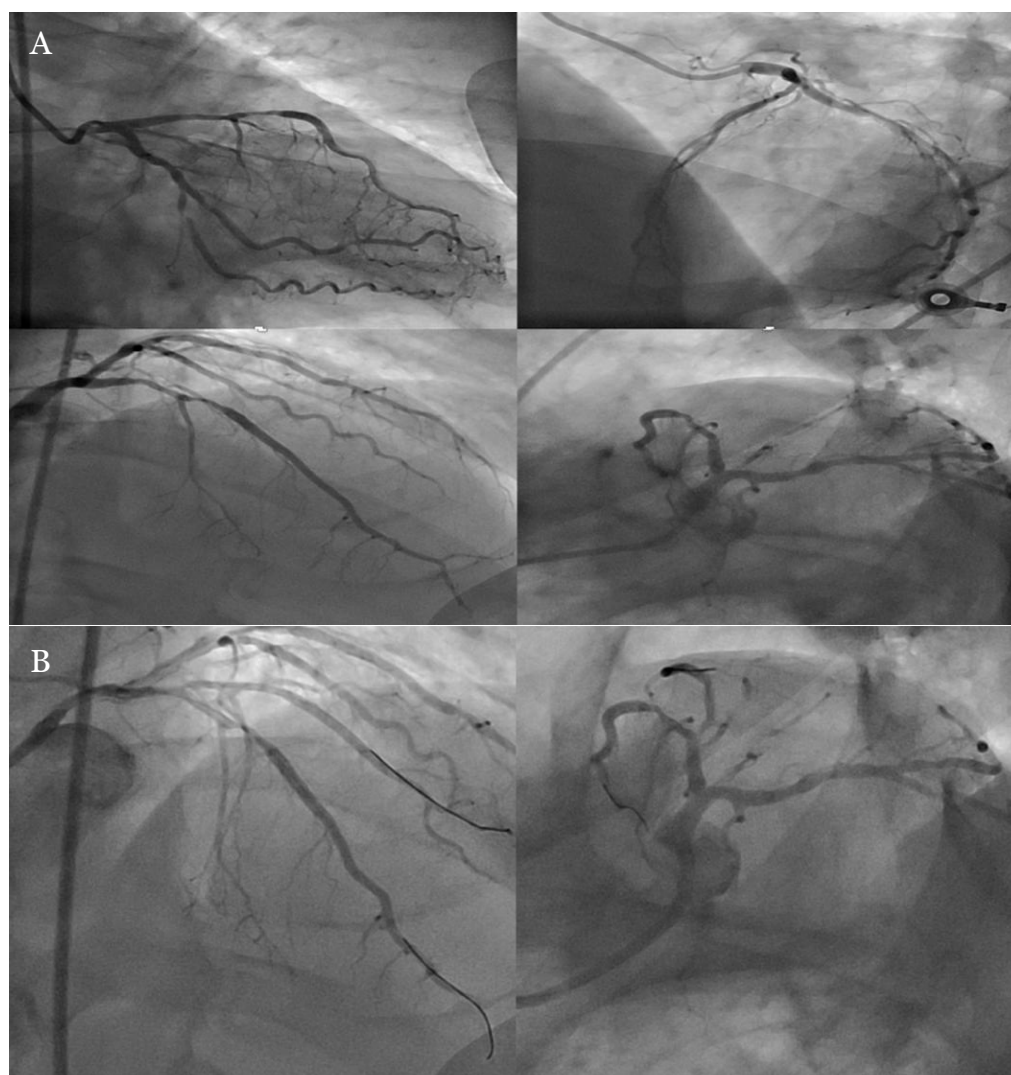


Figure 2. Coronary angiographic identification of the first diagonal branch occlusion and culprit ostial lesion. (A) Initial coronary angiography demonstrating 70–80% stenosis of the proximal-to-mid left anterior descending artery (LAD) and complete occlusion of the first diagonal branch (D1), with an angiographically obscured D1 ostium. (B) Angiography after successful guidewire crossing of the occluded D1, revealing a critical 95% ostial stenosis and confirming the culprit lesion.

Proximal optimization technique (POT) was subsequently performed using a 3.25×12 mm non-compliant balloon. The D1 branch was then rewired using a separate Runthrough NS Hypercoat guidewire. Kissing balloon inflation was performed using a 3.25×12 mm non-compliant balloon in the LAD and a 2.5×15 mm semi-compliant balloon in the D1 branch to optimize the bifurcation geometry and restore optimal side-branch patency. A final re-POT was subsequently performed.

Post-PCI IVUS demonstrated a minimal stent area of 7.0 mm². Final coronary angiography demonstrated an excellent angiographic result with restoration of coronary blood flow and no significant residual stenosis or procedural complications (**Figure 4**).

The patient's chest pain resolved completely following revascularization, and he remained hemodynamically stable throughout hospitalization without recurrent ischemia or arrhythmias. He was discharged after 3 days of hospitalization on guideline-directed medical therapy for STEMI, including dual antiplatelet therapy, high-intensity statin therapy, beta-blocker, and renin–angiotensin system inhibition as clinically appropriate. At 2-week outpatient follow-up, he remained free of chest pain and was hemodynamically stable without reported recurrent ischemic symptoms.

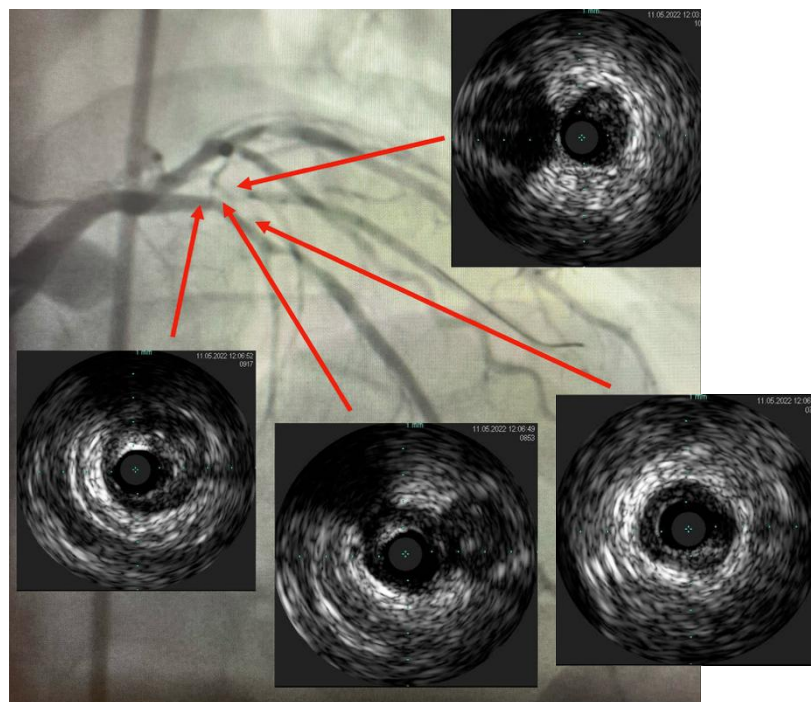


Figure 3. Intravascular ultrasound (IVUS) of the left anterior descending artery (LAD) demonstrated a distal reference vessel diameter of 2.75 mm and a proximal reference vessel diameter of 3.25 mm, with mixed atherosclerotic plaque. IVUS of the first diagonal branch (D1) demonstrated a reference vessel diameter of 2.25 mm.

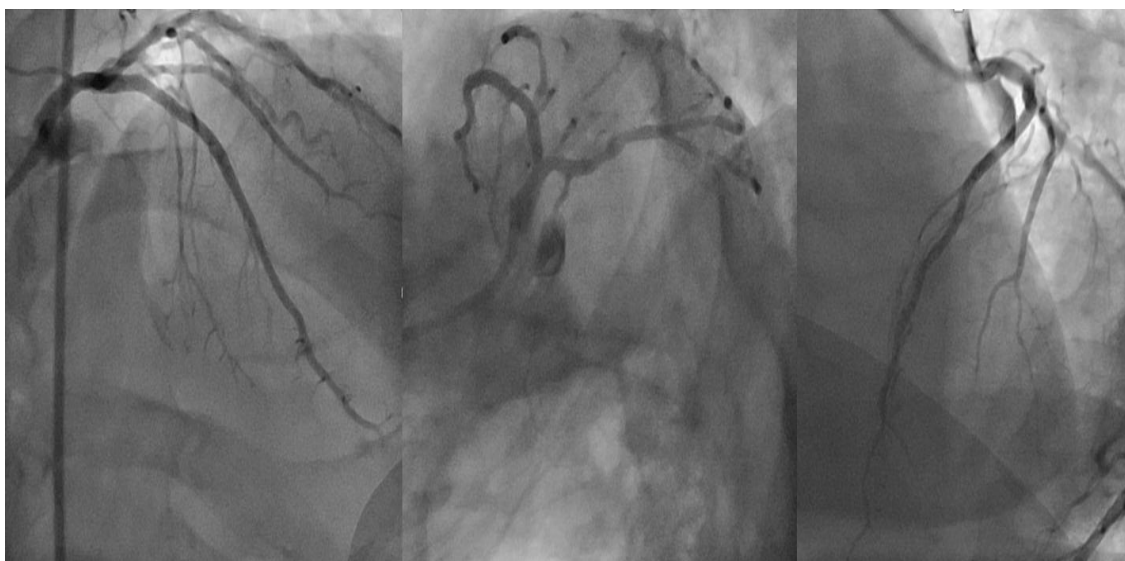


Figure 4. Final coronary angiogram demonstrating an optimal angiographic result following successful percutaneous coronary intervention (PCI).

Discussion

Acute occlusion of the first diagonal (D1) branch is an uncommon cause of STEMI and often presents a diagnostic challenge because its electrocardiographic manifestations differ from those of more common culprit vessels [6-9]. Unlike occlusion of the LAD artery, which typically produces contiguous anterior ST-segment elevation, isolated D1 occlusion characteristically results in ST-segment elevation in leads I, aVL, and V2, accompanied by reciprocal ST-segment depression in the inferior leads. This distinctive ECG pattern, known as the South African flag sign, serves as a practical visual aid to facilitate recognition of acute high-lateral myocardial infarction caused by D1 occlusion [10-11]. Although the sign is highly specific, it remains

underrecognized in routine clinical practice, increasing the risk of delayed identification of the culprit vessel and potentially postponing reperfusion therapy [12-16].

In the present case, the admission ECG demonstrated the classic South African flag sign, prompting suspicion of acute D1 occlusion before coronary angiography. Subsequent angiography confirmed complete thrombotic occlusion of the first diagonal branch. Recognition of this ECG pattern was particularly valuable because the ostium of the D1 branch was angiographically obscured by total occlusion, making the culprit lesion difficult to identify during the initial angiographic assessment. This case therefore illustrates the complementary role of ECG interpretation and coronary angiography in localizing the infarct-related artery.

The electrophysiological basis of the South African flag sign is related to the direction of the injury current generated by ischemia confined predominantly to the high-lateral wall of the left ventricle. This vector is directed toward leads I and aVL, resulting in ST-segment elevation, while extension toward the anterior wall explains the associated ST-segment elevation in lead V2 [6-11]. Reciprocal ST-segment depression is commonly observed in the inferior leads because these leads are electrically opposite to the high-lateral territory [6-11]. Without awareness of this characteristic pattern, clinicians may mistakenly attribute the ECG findings to isolated lateral wall infarction caused by left circumflex artery occlusion or interpret the inferior ST-segment depression as evidence of concomitant inferior ischemia [6-11]. Careful interpretation of all 12 ECG leads is therefore essential for accurate localization of the culprit vessel.

Another educational aspect of this case was the complexity of the coronary anatomy. Initial angiography demonstrated severe stenosis of the proximal-to-mid LAD with complete occlusion of the D1 branch; however, the origin of the diagonal branch could not be clearly visualized because of thrombotic occlusion. Multiple guidewire attempts were required before successful wiring of the D1 branch, which subsequently revealed a critical 95% ostial stenosis. Such anatomical challenges are well recognized in coronary bifurcation interventions, particularly when side-branch occlusion obscures the vessel origin. In these situations, familiarity with coronary anatomy, meticulous guidewire manipulation, and patience are essential to achieve successful lesion crossing while minimizing procedural complications.

This case also highlights the value of IVUS in the management of complex coronary bifurcation lesions. IVUS enabled accurate assessment of vessel dimensions, plaque morphology, and reference vessel diameter, thereby facilitating appropriate stent sizing and optimization of the intervention [17-21]. Contemporary evidence consistently demonstrates that IVUS-guided PCI is associated with improved stent expansion, reduced rates of target lesion failure, and lower incidences of stent thrombosis compared with angiography-guided PCI, particularly in complex lesions such as bifurcations, long lesions, chronic total occlusions, and heavily calcified vessels [17-21]. In the present case, IVUS provided confidence that a provisional one-stent strategy was appropriate despite the complexity of the bifurcation lesion.

Previous reports of the South African flag sign have primarily focused on its electrocardiographic characteristics and diagnostic utility in identifying acute first diagonal artery occlusion [1-12]. However, procedural aspects of managing these lesions have been infrequently described. In the present case, recognition of the characteristic ECG pattern enabled early suspicion of D1 occlusion before coronary angiography. This was particularly valuable because the ostium of the D1 branch was angiographically obscured by acute thrombotic occlusion, making identification of the culprit vessel technically challenging. Furthermore, intravascular ultrasound facilitated accurate assessment of vessel morphology and optimization of a provisional bifurcation PCI strategy. These procedural insights extend the educational value of previous reports by illustrating how characteristic ECG findings can directly influence interventional planning and successful treatment of complex coronary bifurcation lesions (**Table 1**).

Current European Bifurcation Club recommendations and international PCI guidelines advocate a provisional one-stent strategy as the preferred approach for most non-left main coronary bifurcation lesions because it provides procedural simplicity while achieving clinical outcomes comparable to more complex two-stent techniques [22-24]. Following crossover drug-eluting stent implantation from the LAD, POT was performed to optimize proximal stent expansion and facilitate side-branch rewiring. Subsequent kissing balloon inflation and repeat

POT restored optimal bifurcation geometry and minimized the risk of side-branch compromise [13-15]. This systematic approach contributed to an excellent final angiographic result with restoration of coronary flow and complete resolution of ischemic symptoms.

Table 1. Previous reports of the South African flag sign have primarily described its ECG characteristics and diagnostic value, with limited data on procedural management

Study	Clinical presentation	ECG findings	Coronary angiography	PCI strategy	Key educational message
Littmann, 2016 [6]	High-lateral STEMI	Classic South African flag sign	First diagonal artery occlusion	Not emphasized	Introduced the South African flag sign as a practical ECG teaching tool
Rajendran <i>et al.</i> , 2021 [9]	Acute myocardial infarction	South African flag sign	Culprit artery prediction	Not emphasized	Reinforced the diagnostic value of the ECG sign in identifying the culprit vessel
Durant <i>et al.</i> , 2015 [13]	Acute STEMI	ST elevation in I, aVL, and V2	First diagonal artery occlusion	Conventional PCI	Demonstrated the characteristic ECG pattern of isolated D1 occlusion
Present case	Acute STEMI with concealed D1 ostium and complex bifurcation lesion	Classic South African flag sign enabling early recognition before angiography	Angiographically obscured D1 ostium with proximal-to-mid LAD disease	IVUS-guided provisional bifurcation PCI with crossover DES, POT, kissing balloon inflation, and re-POT	Demonstrates how early ECG recognition guided procedural planning and successful IVUS-guided management of a technically challenging non-left main bifurcation lesion

D1: first diagonal branch; DES: drug-eluting stent; ECG: electrocardiogram; IVUS: intravascular ultrasound; LAD: left anterior descending artery; PCI: percutaneous coronary intervention; POT: proximal optimization technique; re-POT: repeat proximal optimization technique; STEMI: ST-elevation myocardial infarction

From a clinical perspective, this case reinforces several important teaching points. First, careful interpretation of the 12-lead ECG remains indispensable for rapid identification of the infarct-related artery, even in the era of advanced intracoronary imaging. Recognition of the South African flag sign should immediately raise suspicion for acute D1 occlusion, allowing interventional cardiologists to anticipate challenging bifurcation anatomy before angiography. Second, IVUS should be considered whenever complex bifurcation PCI is anticipated because intravascular imaging provides valuable anatomical information beyond conventional angiography and facilitates optimization of procedural outcomes. Finally, adherence to evidence-based bifurcation PCI principles, including provisional stenting, proximal optimization, side-branch assessment, kissing balloon inflation when indicated, and final re-POT, remains fundamental to achieving durable procedural success.

Overall, this case demonstrates how the integration of careful ECG interpretation, detailed anatomical assessment using IVUS, and contemporary bifurcation PCI techniques enabled successful treatment of a complex non-left main coronary bifurcation lesion presenting as an acute D1 occlusion. Increased awareness of the South African flag sign may improve early diagnosis, facilitate procedural planning, and ultimately contribute to better clinical outcomes in patients presenting with high-lateral STEMI.

Conclusion

The South African flag sign is an uncommon but clinically important ECG pattern that should raise immediate suspicion for acute first diagonal artery occlusion. Recognition of this sign before coronary angiography may facilitate early identification of the culprit vessel and assist in planning timely revascularization. This case demonstrates that IVUS-guided provisional stenting is an

effective strategy for treating complex non-left main coronary bifurcation lesions, even when the diagonal branch ostium is angiographically obscured by acute occlusion. The integration of careful ECG interpretation, intravascular imaging, and evidence-based bifurcation PCI techniques can optimize procedural success and improve patient outcomes. Increased recognition of this characteristic ECG pattern may help clinicians avoid diagnostic pitfalls and enhance the management of high-lateral STEMI.

Ethics approval

Not required. Written informed consent was obtained from the patient for publication of this case report and accompanying images.

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Competing interests

The authors declare that there is no conflict of interest

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Underlying data

All data underlying the results are available as part of the article and no additional source data are required.

Declaration of artificial intelligence use

ChatGPT (OpenAI) was used during manuscript preparation solely for language refinement, including grammar, sentence structure, readability, and technical writing assistance. It was not used for data collection, data analysis, image interpretation, or generation of clinical conclusions. Authors confirm that all AI-assisted processes were critically reviewed by the authors to ensure the integrity and reliability of the manuscript. The final decisions and interpretations presented in this article were solely made by the authors.

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