

A case report of balloon-assisted tracking to overcome coronary sinus competent valve: a novel technique in left ventricular lead implantation

Mohamed Samy ^{1*} and Rehab M. Hamdy²

¹Cardiology Department, Al-Azhar University, Mokhaim Al-Daemstreet, Mokhaim Al-Daem street, Nasr City, Cairo5, Egypt; and ²Cardiology Department, Faculty of Medicine (For Girls), Al-Azhar University, Cairo, Egypt

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Background	Competent lateral and posterolateral valves showed proximal tortuosity that might hinder left ventricular (LV) lead implantation in cardiac resynchronization therapy (CRT).
Case summary	A 57-year-old woman was diagnosed as non-ischaeamic cardiomyopathy, no other comorbidities, complaining of dyspnoea [New York Heart Association (NYHA) class III], and on optimal medical therapy. Electrocardiogram showed left bundle branch block with QRS duration 150 ms. The patient was candidate for CRT. However, during LV lead implantation, a competent posterolateral vein valve and proximal tortuosity hindered LV lead implantation that was overcome by balloon-assisted tracking technique. At 9 months of follow-up, the patient had NYHA class II, ejection fraction improved to 38%, and all implanted leads were still in place.
Discussion	Balloon-assisted tracking technique can be used to cross coronary sinus and smaller veins with competent valves and coronary veins tortuosity.
Keywords	Cardiac resynchronization therapy • Coronary sinus valves • Balloon-assisted tracking • Dilated cardiomyopathy • Case report
ESC Curriculum	5.11 Cardiac resynchronization therapy devices • 6.2 Heart failure with reduced ejection fraction • 6.1 Symptoms and signs of heart failure

Learning points

- Anatomical and technical challenges can hinder optimal left ventricular (LV) lead placement using traditional lead implantation approaches.
- Venous tortuosity and competent coronary vein valve are considered challenging difficulties encountered during LV lead implantation.
- Using balloon-assisted tracking technique was successful to overcome coronary vein valve and tortuosity in our case.

Introduction

Cardiac resynchronization therapy (CRT) has become one of the established treatment options for congestive heart failure patients

with electrical dyssynchrony, and its usage has been widely increasing in the recent decade.¹ Placement of the left ventricular (LV) lead should target the most delayed segments of the left ventricle. Implanting the left ventricle in targeted veins is one of the most

* Corresponding author. Tel: 002-01281822116, Email: mohammed.samy82@gmail.com

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challenging difficulties during the procedure that may affect the success of the procedure and long-term outcome.² Difficulties in LV lead implantation had been encountered due to many reasons such as limited required equipments/resources, anatomic variations, and poor experience of the operators, despite that most of the procedures had been performed successfully. Various tools and techniques have been described to achieve an optimum LV lead implantation.^{3,4} In our case, challenging anatomic variation restrained the coronary sinus (CS) lead implanted through the posterolateral branch of the CS and a novel technique was used to achieve successful implantation.

Timeline

Date	Event
5 April 2019	First presentation at outpatient clinic with signs and symptoms of congestive heart failure [New York Heart Association (NYHA) class III] with no history of chest pain, palpitation or syncope.
13 April 2019	Echocardiographic assessment revealed dilated LV with LV ejection fraction (EF) = 25% by 2D, severe mitral and tricuspid regurgitation with mild pulmonary hypertension. Assessment of mechanical dyssynchrony revealed increased septal to posterior wall delay (170 ms).
14 April 2019	Optimum medical treatment was initiated including bisoprolol, valsartan, furosemide, and spironolactone.
May 2019	Computed tomography coronary angiography was done to rule out coronary artery stenosis.
October 2019	No remarkable improvement was noticed after 3 months. She was advised for cardiac resynchronization therapy (CRT) implantation.
February 2020	Time lag occurred due to administrative and technical issues. CRT was implanted using balloon-assisted tracking for LV lead placement.
Post-implantation	Electrocardiogram showed QRS duration of 92 ms with dominant R in V1.
May 2020	Improvement of the patient's symptoms (NYHA II) and EF (35%).
November 2020	No change in NYHA class (II) but EF showed further improvement (38%) and all implanted leads were still in place.

Case presentation

A 57-year-old female patient with non-ischaemic cardiomyopathy, no other comorbidities, presented with dyspnoea New York Heart

Association (NYHA) class III, and on optimal heart failure medications including angiotensin-converting enzyme inhibitor, β -blocker, mineralocorticoid receptor blocker, and loop-diuretic for 1 year. Physical examination revealed the following results: pulse was 105 b.p.m.; blood pressure was 100/70 mmHg; and congested neck veins with mild bilateral lower limb oedema. Electrocardiogram (ECG) showed left bundle branch block with QRS duration 150 ms (*Figure 1A*) without remarkable improvement.

She was evaluated by echocardiography that revealed a dilated LV with LV ejection fraction (EF) = 25% by 2D, severe mitral and tricuspid regurgitation with mild pulmonary hypertension. Assessment of mechanical dyssynchrony revealed increased septa-to-posterior wall delay (170 ms) (*Figure 1B and C*). Computed tomography coronary angiography was done to rule out coronary artery stenosis.

Patient was a candidate for CRT. During the procedure, the patient was in conscious sedation. After sterilization and preparation of the patient, left pectoral incision was performed for cannulation and wiring of left subclavian vein. Coronary sinus was cannulated successfully using a decapolar non-deflectable electrophysiological catheter (Response-Decapolar CSL-Catheter 6-F—St. Jude Medical) then peel away CS catheter was introduced over it.

After successful cannulation of the CS, coronary venography showed two branches; a great cardiac vein, and a small-sized lateral branch with a proximal kink (*Figure 2A*). With an advancing CS sheath along the great cardiac vein, venography demonstrated a large posterolateral vein that fills retrogradely with marked proximal tortuosity (*Figure 2B*).

Wiring of the lateral branch was done using PT2 LS 0.014-inch percutaneous transluminal coronary angioplasty (PTCA) wire (Boston Scientific) but the lead position was unstable due to the small size of the vein in addition to phrenic nerve stimulation.

We shifted to cannulation of the posterolateral vein that was wired with difficulty using PT2 LS PTCA wire 0.014-inch (Boston Scientific). Advancing the LV lead over the wire failed so, a compliant coronary balloon, Maverick PTCA Balloon Catheter (Boston Scientific) 1.5 \times 15 mm was easily advanced to the distal segment of the vein. Balloon was inflated up to 8 ATM at posterolateral vein ostium trying to advance the lead along the PTCA wire, but again we failed to insert the lead (*Figure 3B*).

Another wire Asahi Intermediate Guide Wire 0.014-inch (Asahi Intec, Japan) advanced (buddy wire and anchor technique) for sheath stability and facilitation of CS lead insertion were used. Buddy wire technique was tried using two angioplasty wires (PT2 MS PTCA wire 0.014-inch and Asahi Intermediate Guide Wire 0.014-inch) to straighten the posterolateral vein. The anchor technique using Maverick PTCA Balloon positioned at the distal part of the posterolateral vein and its shaft held with backward force. Both techniques failed also to implant the lead. We failed to cannulate the vein using a sub-selector (*Figure 3C*).

Owing to venous tortuosity and severely competent valve evidenced by late venous filling in addition to trials of all available interventions, we decided to use balloon-assisted tracking (BAT) to overcome the competent valve. Maverick non-compliant (NC) PTCA Balloon Catheter (Boston Scientific) 2 \times 20 mm was used protruding from the sub-selector and inflated at 12 ATM and both the sub-selector and the balloon were advanced over the PTCA Asahi

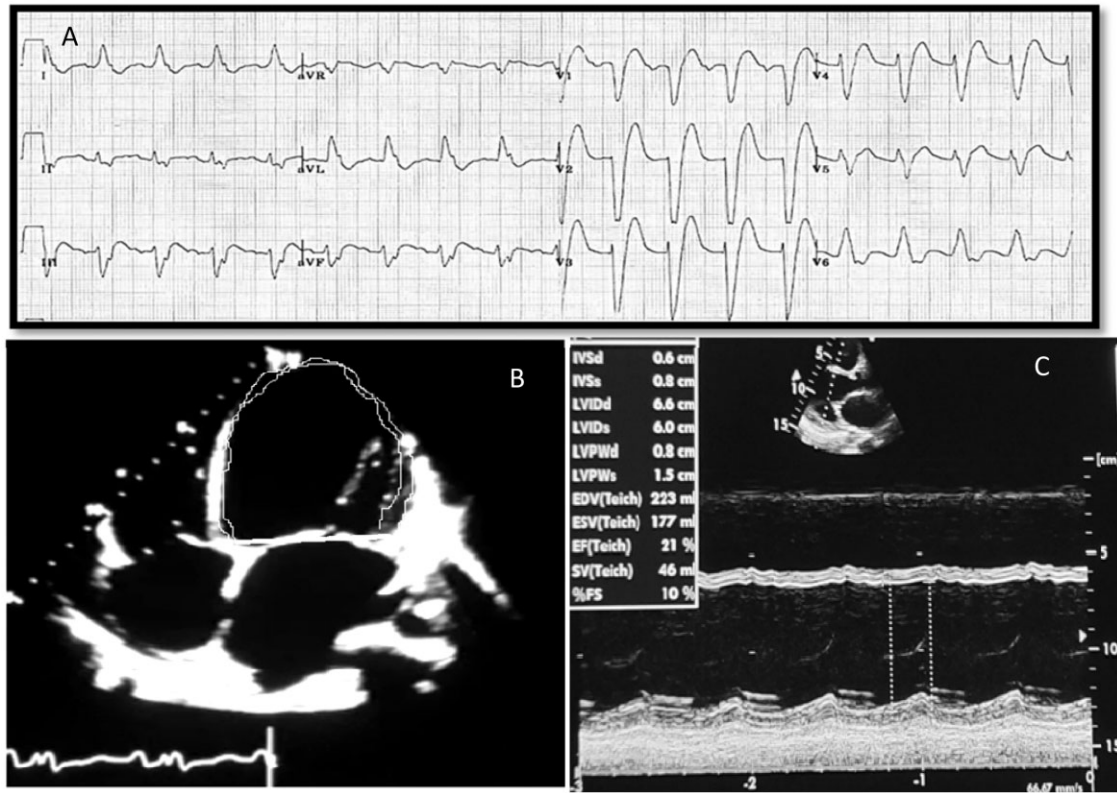


Figure 1 (A) A 12-lead surface electrocardiogram at speed of 25 mm/s showed left bundle branch block. (B) Apical four-chamber view showing impaired left ventricular systolic function (left ventricular ejection fraction = 25%) using biplane Simpson method and (C) M-mode in the parasternal long-axis view at left ventricular mid-cavity showed increased dimensions and impaired left ventricular ejection fraction.



Figure 2 Right anterior oblique-coronary venography at 40° showed (A) small lateral vein, (B) posterolateral vein (red arrow) that fills retrogradely from anterolateral vein (blue arrow).

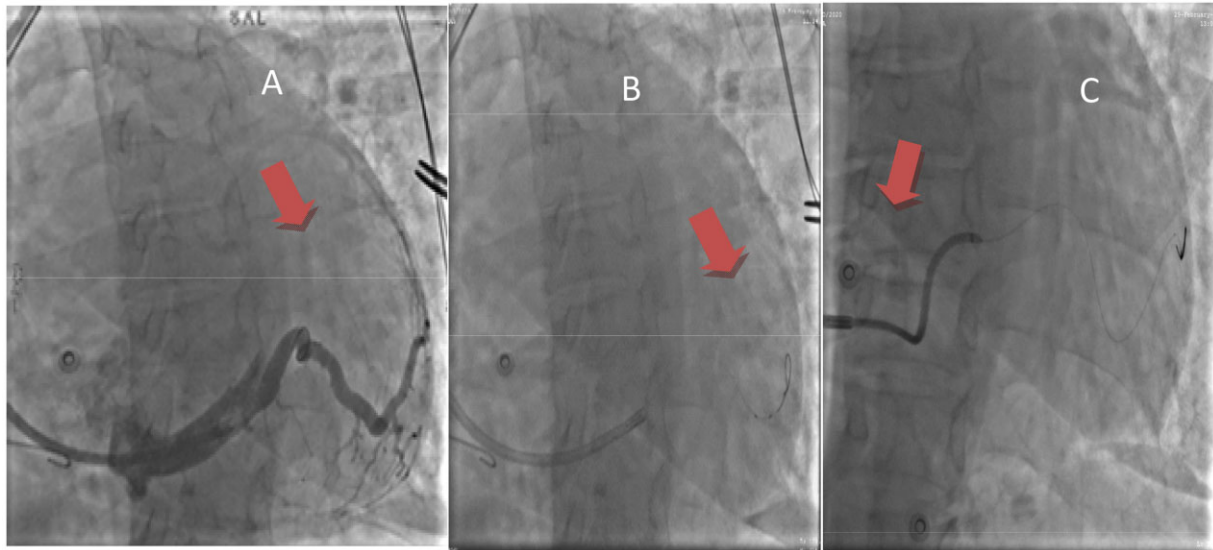


Figure 3 (A) Postero-anterior view coronary venography showed marked tortuosity at proximal posterolateral vein, (B) postero-anterior view showed percutaneous transluminal coronary angioplasty wire and balloon at posterolateral vein and (C) right anterior oblique view at 30° showed trial to advance sub-selector catheter failed with kinking of catheter shaft.

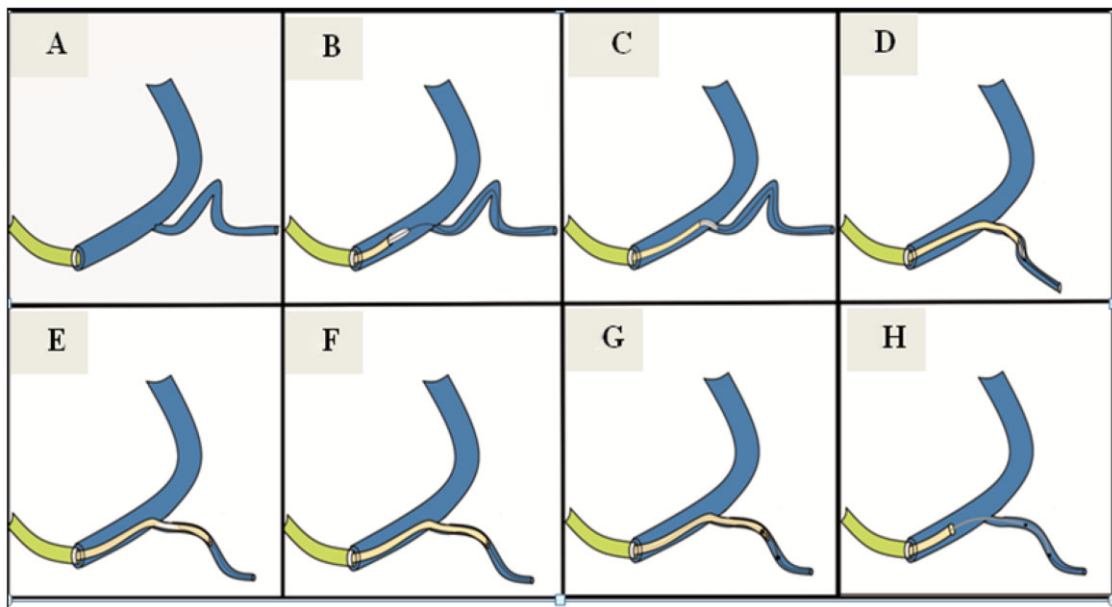


Figure 4 Step by step schematic representation of balloon-assisted tracking used to cross both competent vein valve and proximal tortuosity, the inner catheter could be easily advanced to mid-segment of the posterolateral vein and lead was easily advanced to targeted position. (A) Cannulation of CS by CS sheath, (B) Positioning the PTCA wire in the targeted vein, 2 x 20 balloon was inflated that was partially protruding from the inner coronary catheter, (C) The whole system (both inner catheter and the balloon) were advanced over the wire and the balloon crossed the valve successfully, (D) The inner catheter was successfully advanced to the targeted vein crossing the competent valve and proximal tortuosity, (E) Balloon was deflated and withdrawn, (F) The LV lead was advanced over the PTCA wire, (G) The LV lead was positioned easily in the middle of the targeted vein, (H) The inner catheter was withdrawn leaving the LV lead in the targeted position.

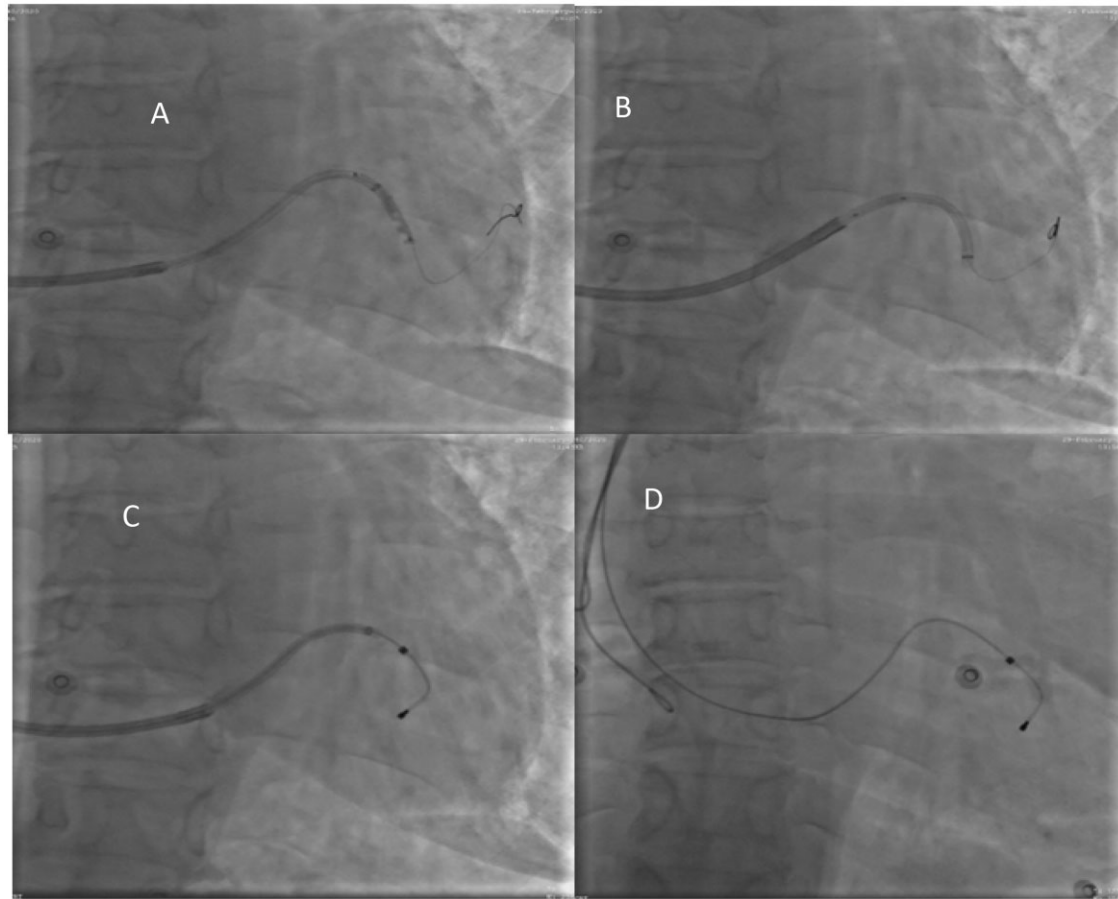


Figure 5 Right anterior oblique views at 30° showed successful left ventricular lead implantation in posterolateral vein: (A) balloon-assisted tracking with advancing sub-selector to posterolateral vein, (B) balloon deflation and withdrawal, (C) advancing left ventricular lead to mid-part of posterolateral vein, and (D) after removal of inner and outer sheaths.

Intermediate Guide Wire to pass both the competent valve and the tortuous segment as well as to prevent CS dissection (Razor effect). The sub-selector successfully passed and cannulated the posterolateral vein, and then the LV lead (St. Jude Medical—QUICKFLEX-Left-Heart Lead-86 cm) was implanted easily and finally through it (Figures 4A–H and 5A–D).

Good sensing and pacing parameters without diaphragmatic stimulation were obtained. Lastly, the right ventricular (RV) lead (St. Jude Medical—Tendril STS Pacing Lead, 58 cm) was conventionally implanted at the RV apex then the right atrial (RA) lead was implanted at the right atrial appendage (St. Jude Medical—Tendril STS pacing lead, 52 cm). All electrodes were connected to a biventricular pacemaker battery (St. Jude Medical—Allure RF) that was implanted subcutaneously in the pocket.

Post-implantation ECG showed QRS duration of 92 ms with dominant R in V1. Follow-up of the patient after 3 then 6 months showed that the patient had NYHA class II, EF improved to 35 then 38% and all implanted leads were still in place.

Discussion

Many factors have been described to determine the CRT response; one of them being the ability to implant the LV lead at the desired location. Sometimes, there is still some difficult to reach the target branch. Innovative and alternative techniques can provide the solution for successful LV lead implantation.⁵

The anatomical variants of the CS are manifold including tortuosity of selected branch of the CS, side branch arise at steep angles, smaller diameter side branch, stenotic segments in the body of the CS or selected side branch, and the absence of suitable side branches and the competency of luminal valves. All tributaries, except for the oblique vein of the left atrium, contain valves at their junction with the CS.⁶ While most anatomical variants are benign, some hold clinical implications for cardiac procedures such as CRT implantation. Extreme venous tortuosity with an acute angle close to the origin of the vein evaluated during coronary venography represent anatomical obstacles, which impede the progression of the guiding catheter, and thus affect the support being provided to the lead.⁷ Additionally, the

presence of anomalous valves in the CS may also hinder cardiac intervention techniques.⁸

Venous valves within the major LV veins were prevalent in human hearts and were present most often at the ostia to smaller branch veins. Anterior interventricular veins, posterior veins of the left ventricle, and posterior interventricular veins had more valves per vein than left marginal veins. While presence and development of these venous valves are variable.⁹

The most common valve is the Thebesian valve at the ostium of the CS. The Thebesian valve is highly variable and occasionally may present an obstruction during cannulation of the CS.¹⁰ Valves can be found in the CS at various locations. Most common are at the ostium of the CS (Thebesian valve) and at the ostium of the posterolateral vein at the junction of the Great Cardiac vein and CS (Viessens's valve). These valves cover various extents of the area of the orifice.¹¹

Inner catheters, buddy wires, looped guide wires, and balloon anchoring are frequently used tools and techniques to facilitate CS lead implantation.^{3,4}

Balloon-assisted tracking had been previously described to manage arterial perforation during transradial approach during coronary arterial angiography. Balloon-assisted tracking was used to facilitate passage of a catheter through the area of spasm and internally tamponade the perforation.¹² To the best of our knowledge, BAT was not previously described during CS lead implantation. However, it facilitated crossing both the valve and tortuosity without causing dissection of the CS. Therefore, in those patients with tortuous CS branches and competent valves, BAT could improve the success rate of LV lead placement when other techniques failed.

Conclusions

Left ventricular lead positioning CRT remains the most challenging and important determinant that predicts response to CRT. Anatomical and technical challenges can hinder optimal LV lead placement using traditional lead implantation approaches. Using BAT is a feasible and easily applicable technique that can overcome competent venous valves besides acute vein takeoff angle and marked venous tortuosity.

Lead author biography



Dr Mohamed Samy MD cardiovascular medicine, lecturer of cardiology and consultant of cardiac electrophysiology Al-Azhar University.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with the COPE guidance.

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