Retrograde Venography to Navigate an Occluded Subclavian Vein to Achieve CRT Upgrade via His Bundle Pacing

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March 30, 2022

Abstract

We present a case of pacing-induced cardiomyopathy and an occluded left subclavian vein (SCV). The SCV occlusion was delineated in a retrograde manner from femoral venous access and bypassed through direct puncture of a collateral branch. Cardiac resynchronisation therapy was achieved through His bundle pacing, with subsequent normalisation of LV function.

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Total word count excluding abstract 1496 (allowed 1500)

Funding : (None)

Disclosures : (None)

Abstract - 50 words

We present a case of pacing-induced cardiomyopathy and an occluded left subclavian vein (SCV). The SCV occlusion was delineated in a retrograde manner from femoral venous access and bypassed through direct puncture of a collateral branch. Cardiac resynchronisation therapy was achieved through His bundle pacing, with subsequent normalisation of LV function.

History of presentation:

An 83-year-old man with a history of AV block and a single-chamber (RV lead) permanent pacing system (in-situ 9 years) was referred to our institution with worsening breathlessness (NYHA III). Clinical examination revealed signs of fluid overload (raised JVP and bilateral lower leg oedema) with no murmurs on auscultation.

Learning Objectives

To understand the potential techniques available to overcome lead-related venous occlusion when performing a device upgrade

To demonstrate how cardiac resynchronization therapy may be achieved through His-Bundle pacing

Past Medical History

This included an ablation for cavotricuspid isthmus dependent flutter, and mild chronic obstructive pulmonary disease. There was a remote history of alcohol excess and transthoracic echocardiography (TTE) at the time of original device implantation showed preserved left ventricular systolic function (LVEF 55%).

Differential diagnosis

The most likely diagnosis explaining this presentation was pacing-induced cardiomyopathy (PIC), differentials included alcohol-induced cardiomyopathy, or post ablation atrial arrhythmia.

Investigations

12-lead ECG showed sinus rhythm with AV dissociation as a result of RV-only pacing. Device interrogation confirmed 100% RV pacing with underlying complete AV block with a broad escape rhythm (LBBB, QRS duration 132ms). TTE revealed a non-dilated LV with moderately impaired systolic function (LVEF 40-45%), with late septal activation consistent with RV apical pacing. RV function and pulmonary pressures were normal, with no significant valve abnormalities.

Management

Despite guideline-directed medical therapy his heart failure symptoms persisted. Considering the LV impairment and dyssynchronous ventricular activation, he was offered a device upgrade to a CRT-P with either a conventional LV lead or a His bundle lead, in addition to an RA lead to improve VV and AV synchrony, respectively. Prior to implantation left sided venography was performed to evaluate vein patency which showed an occluded subclavian vein (Figure 1). Options considered included: 1) a contralateral CRT-P implantation; 2) implanting a right sided RA and LV lead and tunneling across to the left; 3) venoplasty facilitated CRT-upgrade; 4) lead extraction of the functional RV lead for re-canalisation and upgrade; 5) a conservative approach. After careful discussion, the patient elected to proceed with an upgrade strategy (including venoplasty and lead extraction).

As a centre with experience in His Bundle pacing (HBP), and in alignment with recent AHA/ACC guidelines (1), we targeted CRT-P via this approach. The least aggressive strategy was preferable and therefore prior to opening the left-sided pocket, the SCV occlusion was probed in a retrograde manner using a multipurpose catheter (6F MPA1 Impulse, Boston Scientific, Mass) from right femoral venous access (secured for temporary pacing wire support). In doing so, we were able to direct the catheter to the brachio-cephalic vein and define the occlusion in detail. Furthermore, contrast highlighted a large collateral branch, which we felt could be punctured directly from a left sub-clavicular approach (Figure 1). We left a 0.035in J wire in this branch, and successfully secured venous access through the Seldinger technique (Figure 2, Video 1). A passive lead to the right atrial appendage was implanted and a 69cm Select Secure 3830 lead (Medtronic Inc, MN) was deployed via a C315 sheath (Medtronic) at the His bundle.

Intracardiac electrograms confirmed underlying complete AV dissociation with an intrinsic His-QRS_{end} interval of 192ms. With HBP, non-selective capture was achieved resulting in a shortened Stim-QRS_{end} of 158ms with a threshold of 1V at 0.5ms (Figure 3). The device was programmed DDD-60 with an "LV" to

RV delay of 60ms, to allow protective back up RV pacing in the event of loss of His capture. There were no complications and post procedural 12-lead ECG confirmed non-selective His capture.

Discussion:

Venous occlusion is a well described complication after transvenous lead placement with an estimated incidence of 20 to 26% depending on the time since implantation (2,3). Balloon venoplasty and laser lead extraction techniques have been developed to overcome these occlusions but carry with them inherent procedural risks, additional expense and need for specialist training. Whilst retrograde contrast injections to define a venous stenosis has previously been described, its use has been to facilitate bypassing a stenosis with guidewires and ultimately performing venoplasty to allow percutaneous trans-venous lead placement (4). We believe this is the first description of direct percutaneous venous puncture using this technique, avoiding the need for venoplasty or laser lead extraction, thereby lowering procedural risks.

PIC has been estimated to occur in 10-20% of individuals with normal baseline LV function receiving a high RV pacing burden (5). RV pacing results in electrical and mechanical dyssynchrony (6) and chronic RV pacing is associated with an increased risk of heart failure, atrial fibrillation and death (7).

Compared to RV pacing, CRT with biventricular pacing (BVP) improves dyssynchrony, however, it does not restore normal ventricular activation (8,9). HBP enables ventricular activation through the direct stimulation of the His-Purkinje system. This expanding technique results in more physiological ventricular contraction when compared to BVP (8) with reassuring safety and longer-term outcomes (10).

To reduce the risk of PIC the latest ACC/AHA pacing guideline give HBP a class IIa recommendation in patients undergoing pacemaker implantation for AV block, with mild -moderate LV impairment (LVEF 36 to 50%) with an expected RV pacing burden $> 40\%$ (1).

Follow-up

After 2 months the patient was NYHA I, euvolaemic and LV systolic function had normalised (EF $> 55\%$). Device interrogation revealed atrial pacing of 56% and HIS bundle pacing 99% of the time.

Conclusion(s)

Lead related venous occlusion can represent an obstacle to upgrade procedures. Balloon venoplasty and lead extraction techniques can be effective but carry additional risk, cost, and need specialist training. This simple technique may offer an alternative option. His bundle pacing offers an exciting new approach to delivering CRT-P.

Abbreviations

SCV – subclavian vein

CRT - cardiac resynchronisation therapy

HBP – His-bundle pacing

PIC – Pacing induced cardiomyopathy

BVP – Biventricular pacing

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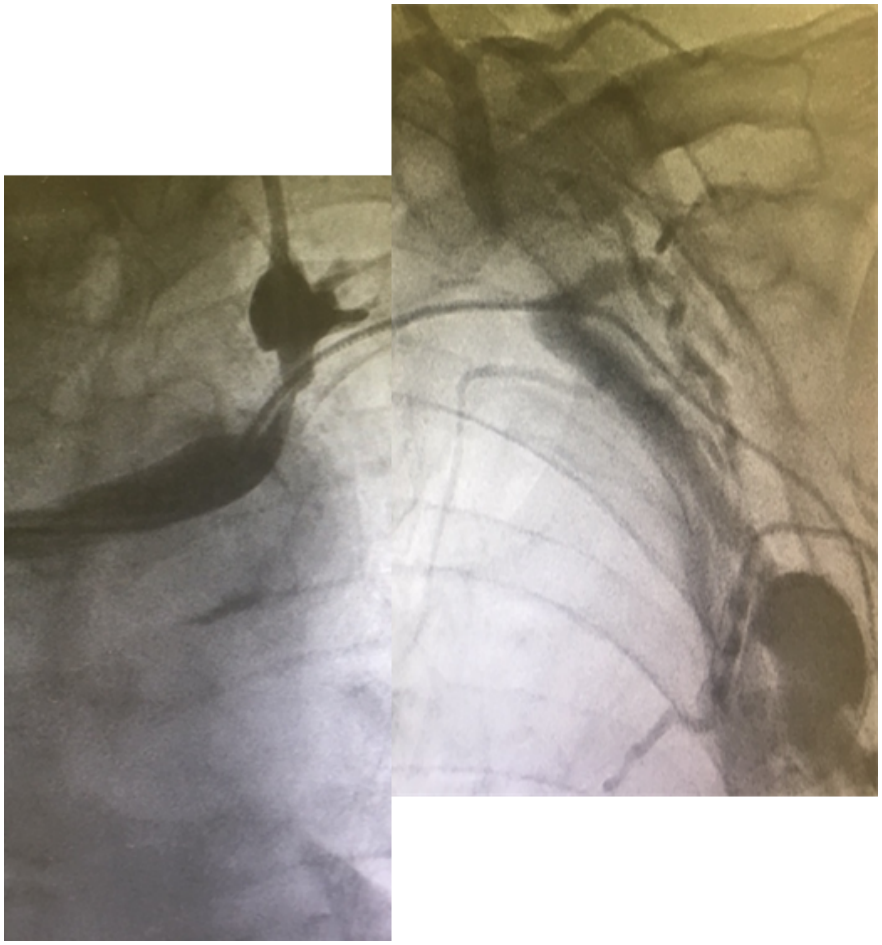
Figure Legends

Figure 1 - Left sided contrast venography (left panel) demonstrating lead-related left subclavian venous occlusion (blue arrow). Retrograde venography (right panel) delineates site of vessel recanalisation (red arrow).

Figure 2/VIDEO 1 - A collateral branch is identified and wired using a J-wire (0.035) to guide direct left sub-clavicular percutaneous puncture, bypassing the occluded left subclavian vein.

Figure 3 - Intracardiac electrograms confirm supra-Hisian AV block (HV association maintained) and evidence of His injury current (blue arrows left panel). His-QRS_{end} interval 192ms (left panel). With His pacing stim-QRS_{end} reduced to 158ms (right panel).



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