Valuable alternative for patients with congenital or acquired interruption of the inferior vena cava

Atrial fibrillation ablation from above

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Summary

Pulmonary vein isolation is a well-established therapy for symptomatic atrial fibrillation. The standard access for left atrial procedures is a transfemoral approach. Rarely, access to the heart from an inferior approach is not feasible due to congenital or acquired interruption of the inferior vena cava. In the present case, we discuss relevant aspects and technical issues related to the superior approach for pulmonary vein isolation.

Introduction

Pulmonary vein isolation (PVI) is a well-established therapy to control symptomatic atrial fibrillation (AF) and represents the most common invasive procedure performed worldwide in the electrophysiology laboratory [1]. The standard access to the left atrium is an inferior approach with femoral venous and transseptal puncture. Accordingly, most of the available tools for transseptal catheterisation (i.e., long fixed-curve or deflectable sheaths, needles and wires) are primarily designed for facilitating a transfemoral venous approach. Rarely, access to the heart via the standard inferior approach is not feasible because of congenital (prevalence between 0.15 and 0.6%) [2] or acquired interruption of the inferior vena cava (IVC). Surgical epicardial ablation or percutaneous catheter ablation (CA) from a superior approach are valuable alternatives for these patients. We describe a case of a patient with congenital IVC interruption who underwent successful PVI via a left axillary vein approach. We discuss relevant aspects and technical issues related to the superior approach for PVI.

Case description

A 61-year-old gentleman was referred to our centre because of symptomatic paroxysmal AF despite antiarrhythmic drug therapy. A first CA attempt in another centre was aborted because of impossibility to advance wires and/or catheters from the IVC to the right heart. Imaging by multislice computed tomography confirmed a congenital IVC interruption (fig. 1). Thus, a superior approach under general anaesthesia and with transoesophageal echocardiography guiding was scheduled. Double venous access from the left axillary vein was obtained using ultrasound guiding. A steerable decapolar diagnostic catheter (Dynamic XT, Boston Scientific, Marlborough, MA) was positioned as a landmark in the coronary sinus. A steerable sheath (SupraCross, Baylis Medical, Quebec, Canada) was advanced under fluoroscopic and transoesophageal echocardiography (TOE) guidance at the level of the fossa ovalis. The dilatator was withdrawn into the sheath in order to allow stable and firm contact of the sheath tip to the septum (fig. 2A, video 1). Transseptal puncture was performed using a radiofrequency wire (SupraCross RF Wire, Baylis Medical) under TOE visualisation (fig. 3). After uneventful transseptal puncture, the pig-tail shaped SupraCross wire was carefully advanced into the left atrium to achieve enough stability and support to advance the whole system into the left atrium (fig. 2B). With the tip of the transseptal sheath held at the septum, the dilatator was advanced into the left atrium with gentle rota-

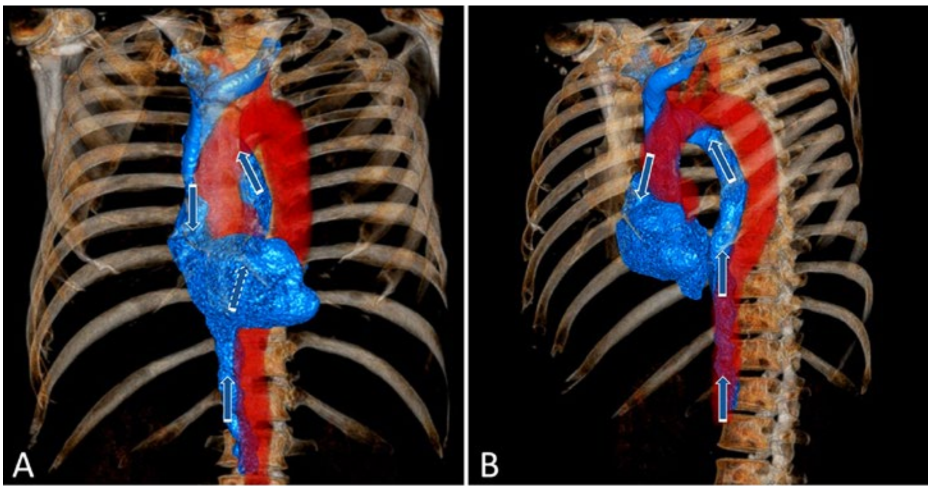

Figure 1: Multislice computed tomography 3-dimensional reconstruction of abdominal and thoracic big vessels (venous system in blue; antero-posterior and left-lateral view panels A and B, respectively) showing absence of direct communication between the inferior vena cava and the right heart. Blue arrows show the venous blood return from the inferior vena cava, through a dilated vena azygos to the superior vena cava and to the right atrium.

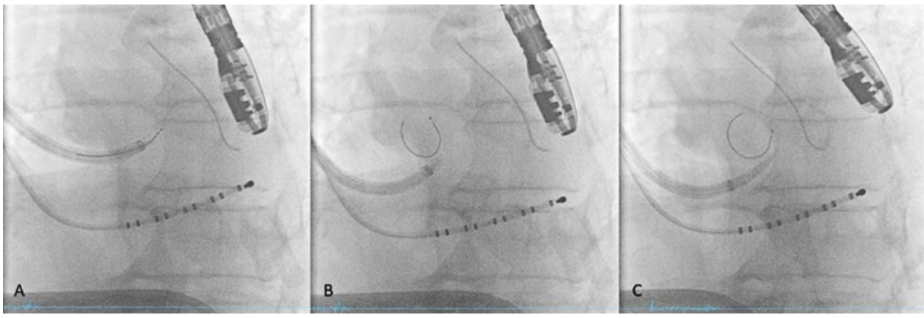

Figure 2: X-ray antero-posterior sequence showing step-by-step how to perform transseptal puncture from above. A decapolar catheter is placed as landmark into the coronary sinus. In panel **A** the tip of a steerable sheat is placed under transoesophageal echocardiographic guidance at the upper anterior part of the fossa ovalis. The dilatator is withdrawn inside the sheath in order to allow better maneuverability and bending the tip of the sheath itself. A radiofrequency wire is advanced through the dilatator and puncture is performed. With the sheath held in place, the wire is advanced into the left atrium (panel **B**). In panel **C**, with gentle back and forth movements the dilatator is advanced into the left atrium.

tional movements under TOE guiding (fig. 2C). Once the transseptal sheath itself had reached the left atrium, intravenous heparin was administered to obtain a target activated clotting time of >350 seconds. Anatomical reconstruction of the left atrium was performed using a multipolar diagnostic catheter (Pentaray, Biosense Webster, Diamond Bar, CA) and a 3D electroanatomical mapping system (CARTO3, Biosense Webster). Antral PVI was successfully performed with a bidirectional, contact-force radiofrequency ablation catheter (Thermocool SmartTouch, Biosense Webster) with a target ablation index of 450 on the anterior wall and 350–400 on the posterior wall. Acute entrance- and exit- block was achieved for all pulmonary veins (fig. 4). Because of a recurrence of symptomatic atrial fibrillation at follow-up, a second CA procedure was performed six months after the index procedure. Durable isolation of all four pulmonary veins was observed. However, highly fractionated signals were found several cm into the superior vena cava (SVC). Accordingly, isolation of the SVC was performed in the second procedure with observation of isolated firing in the SVC after isolation. No complications occurred during and/or after the two procedures.

Discussion

Congenital or acquired IVC interruption is a rare condition preventing the standard transfemoral approach for left atrial procedures, such as PVI or left atrial appendage occlusion [3, 4]. Despite this being an infrequent scenario, cardiologists may face the challenge of performing such procedures via an alternative route. Several options for alternative access routes may be considered, such as epicardial, transepathic or even a surgical approach, these being potentially related to a major risk of complications or side effects (i.e., bleedings, difficult re-access of the epicardial space). Reports on a superior approach are limited. A superior approach via the left axillary / subclavian vein or the right internal jugular vein is probably the best alternative [3–5]. In the case of an enlarged right atrium, a right jugular approach should be preferred because of better contact with the interatrial septum and stability of the sheath. Left axillary access, on the other hand, seems to be favourable in terms of ergonomics and reduction of X-ray exposure for the operator [4]. Of note, this has also consequences for the set-up and organisation of the electrophysiology laboratory for these procedures (anaesthesiology team, echocardiography team, screens). Ultrasound guidance for venous access should be encouraged in order to minimise possible complications. For the transseptal puncture, visual guiding by TOE or intracardiac echocardiography is critical [3]. Although few initial reports describe successful transseptal catheterisation using fixed-curve sheaths and a manually bent Brockenbrough transseptal needle [6], this technique may present several challenges. Since engagement and puncture of the anterior upper part of the fossa ovalis seems to be of advantage, especially to achieve contact during ablation of the septal aspect of the right pulmonary veins, a deflectable sheath should be preferred to a fixed-curve sheath. Furthermore, dilatator withdrawal into the steerable sheath will facilitate manipulation and engagement of the septum, and will allow the dilatator itself to track over the pigtail wire after puncture. In the largest case series available so far, Liang et al. [4] used steerable transseptal sheaths (40 cm Agilis EPI; Abbott Laboratories, Chicago, IL; or 45 cm SupraCross; Baylis Medical), mostly in combination with a dedicated pig-tail shaped radiofrequency access wire (SupraCross RF Wire, Baylis Medical). This wire provides the necessary support to allow crossing of the dilator/sheath unit into the left atrium and eliminates the need for an exchange to a second pigtail wire.

The main technical differences and challenges with superior transseptal access are the following. First, after the fossa ovalis being engaged, advancement of the sheath will not re-

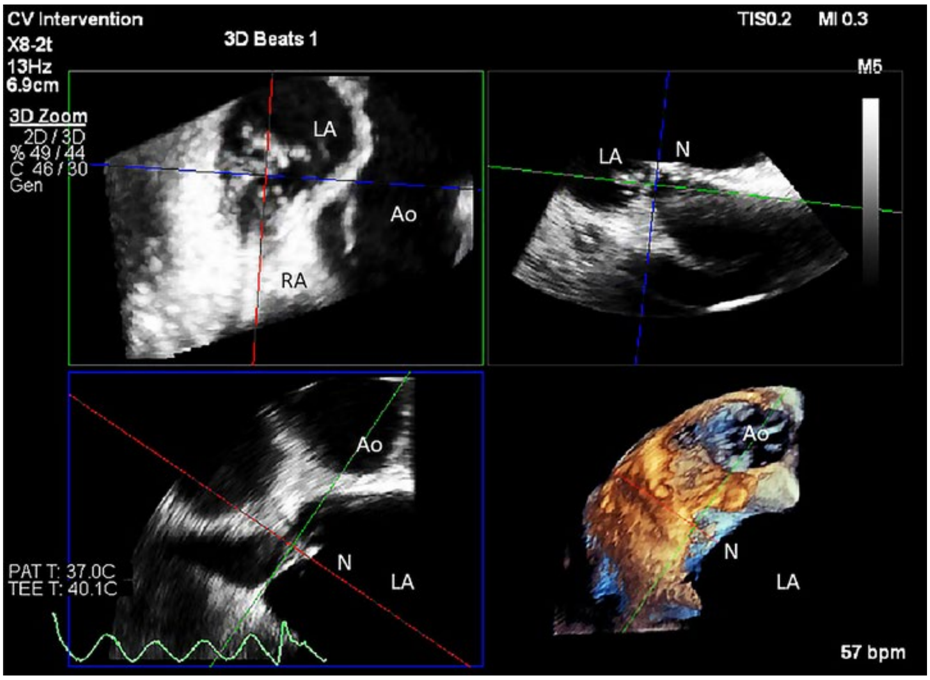

Figure 3: Intraoperative imaging guiding transseptal puncture (see text). While energy is applied via the radiofrequency needle, small bubbles are visualised into the left atrium, confirming successful puncture. RA: right atrium; LA: left atrium; Ao: aorta; N: transseptal needle.

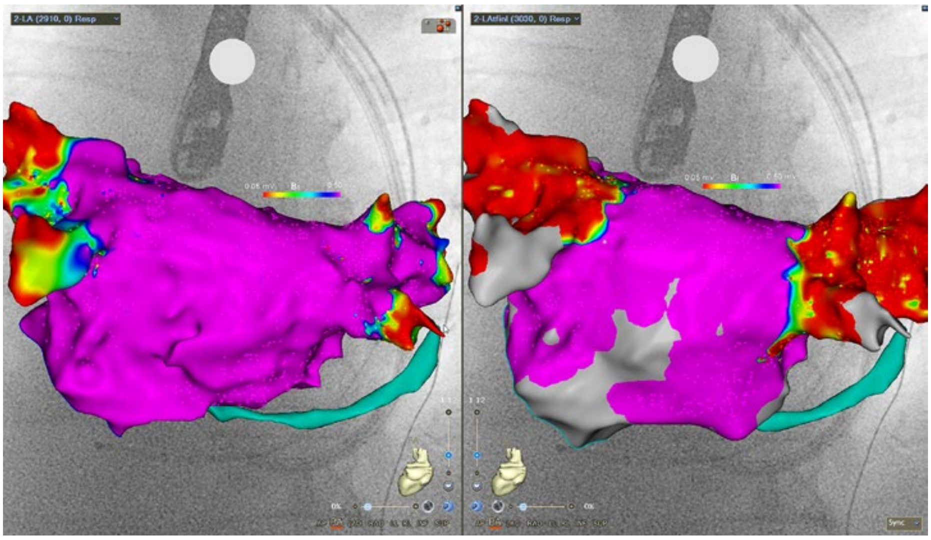

Figure 4: Left atrial electroanatomical map from a posterior view showing successful pulmonary vein isolation: left panel before, right panel after isolation. Magenta colour indicates normal voltage, red shows absence of atrial signals.

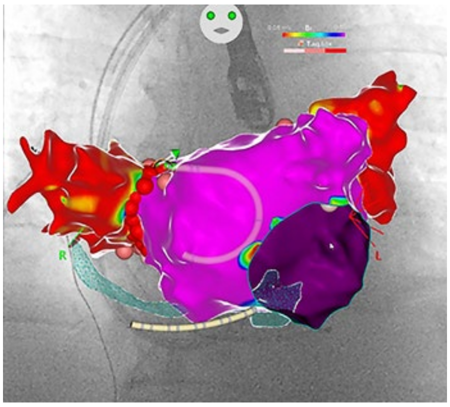

Figure 5: Left atrial electroanatomical map from an anterior view. A large loop of the ablation catheter is required to reach the right veins. Stable contact at the septal aspect of the right-sided pulmonary veins is the most challenging part of pulmonary vein isolation from a superior approach. For this purpose, a puncture of the upper part of the fossa ovalis could be of advantage.

sult in a right-to-left movement such as with the inferior approach. Rather, further advancing the sheath will result in a superior-to-inferior movement and loss of position and contact to the septum. Therefore, after successful transseptal puncture with the wire, the previously retracted dilator needs to be carefully re-advanced through the deflected sheath over the wire into the left atrium. For instance, not rarely advancing the wire into the left ventricle may be necessary. Second, while ablation of the left PVs is usually relatively straight forward, ablation of the right sided PVs often requires a large loop to reach back to the septum (fig. 5). Ablation itself may be performed with both point-by-point as well as by single-shoot device [7]. Reported data on procedure safety, even if based on a very limited experience, appear to be promising. Long-term data on efficacy however are limited to 1-year follow-up, up to which point they look favourable.

Conclusions

In patients with anatomical constraints such as an IVC interruption precluding the standard transfemoral venous approach, transseptal catheterisation and catheter ablation for atrial fibrillation via a superior approach is a feasible and effective alternative. Dedicated tools and team work with imaging specialists for intraoperative guiding are critical for a safe and successful procedure.

Learning points

- Congenital or acquired inferior vena cava interruption are rare conditions, but can preclude standard transfemoral access for left atrial procedures.
- A superior approach for transseptal access and ablation is feasible, but clinical experience is limited in most ablation centres.
- Left axillary or right internal jugular vein are the preferred access sites for a superior transseptal approach.
- Deflectable sheaths and dedicated pigtail radiofrequency wires are more suitable for a superior approach than a fixed-curve sheath and standard Brockenbrough and/or radiofrequency needles.
- Team work with imaging specialists for intraoperative guiding is critical for a safe and successful procedure.

Disclosure statement

No financial support and no other potential conflict of interest relevant to this article was reported.

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