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Pulmonary Vein Isolation and Concomitant Posterior Wall Box Isolation with Pulsed Field Ablation Using a Right Transjugular Access in a Patient with Long-Standing Persistent Atrial Fibrillation

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Abstract

Superior transjugular access may be required when common transfemoral catheterization is not possible. We present the first reported case of pulmonary vein isolation (PVI) and concomitant posterior wall isolation using pulsed field ablation (PFA) via a jugular approach supported by 3D mapping. A 56-year-old patient with persistent atrial fibrillation and chronic inferior vena cava occlusion underwent PVI after a failed femoral attempt. Transseptal puncture directly with the steerable PFA sheath was challenging but feasible under transesophageal echocardiography. The 3D mapping system revealed persistent conduction gaps in the superior veins despite apparent exit block and uncovered additional substrate on the posterior wall. After 90 PFA applications, complete isolation of all veins and the posterior wall was achieved. This case demonstrates that jugular-access PFA is possible but complex, and that 3D mapping significantly enhances navigation and gap detection.

Keywords: Atrial fibrillation; Pulsed field ablation; Jugular vein access; FaraPulse; Pulmonary vein isolation

Introduction

With rising numbers of patients with atrial fibrillation who are eligible for pulmonary vein isolation (PVI) and more centers performing this procedure [1-4], a challenging transfemoral access due to anatomic anomalies is going to occur more often. In such cases, PVI can be performed via a superior access route through the jugular vein. With the introduction of pulsed field ablation (PFA) for PVI, a novel single shot therapy is available, but has been scarcely used in a superior access (three case reports) [5,6], so far without a 3D mapping system to demonstrate successful first pass PVI and to investigate for further left atrial (LA) substrate.

Case Presentation

The 56-year-old patient was referred for PVI for symptomatic long-standing persistent atrial fibrillation after a failed attempt via the conventional transfemoral approach due to chronic inferior vena cava occlusion of unknown cause. After the initial unsuccessful procedure the patient proved to be refractory to medical therapy with class II and III antiarrhythmic drugs (beta blocker and amiodarone) and was hospitalized due to recurrent heart failure episodes in conjunction with atrial fibrillation. The left ventricular ejection fraction was mildly reduced (48%) during the long-lasting AF episodes which is why we opted for rhythm control strategy with a second attempt for PVI via a transjugular access route as well as employing a 3D mapping system to evaluate for further LA substrate. The procedure was performed in deep sedation using continuous propofol infusion as well as bolus administration of fentanyl, ketamine and midazolam when needed. A single left radial arterial catheter achieved continuous hemodynamic monitoring. We performed double ultrasound-guided right internal jugular vein puncture with introduction of one 6F sheath and one 8F sheath. The 6F sheath was used to position a decapolar steerable diagnostic catheter (Inquiry 6F EP catheter, Stryker, MA, USA) in the coronary sinus (CS) both for back-up pacing (if needed) and as reference for the 3D mapping system. The 8F sheath was then directly exchanged for the FaraDrive steerable sheath (Boston Scientific, MA, USA) using a long J-tip wire (InQwire diagnostic guide wire 180 cm (71") F 1.5 mm J-Tip, Merit Medical, UT, USA). The sheath was placed at the interatrial septum using transesophageal echocardiography (TOE) and fluoroscopy guidance. Then transseptal puncture was attempted using a 98 cm needle (BRK 98 cm, Abbott Cardiovascular, MN, USA) and continuous tip pressure monitoring, but failed due to the very steep angle with the superior approach. For the successful attempt, we advanced the needle to the septum with the stylet still inside the needle, performed transseptal puncture with repeated “jabbing” manoeuvres of the stylet, confirmed transseptal position of the stylet via TOE and then slowly pushed the needle with the introducer and the sheath into the left atrium (Figure 1).

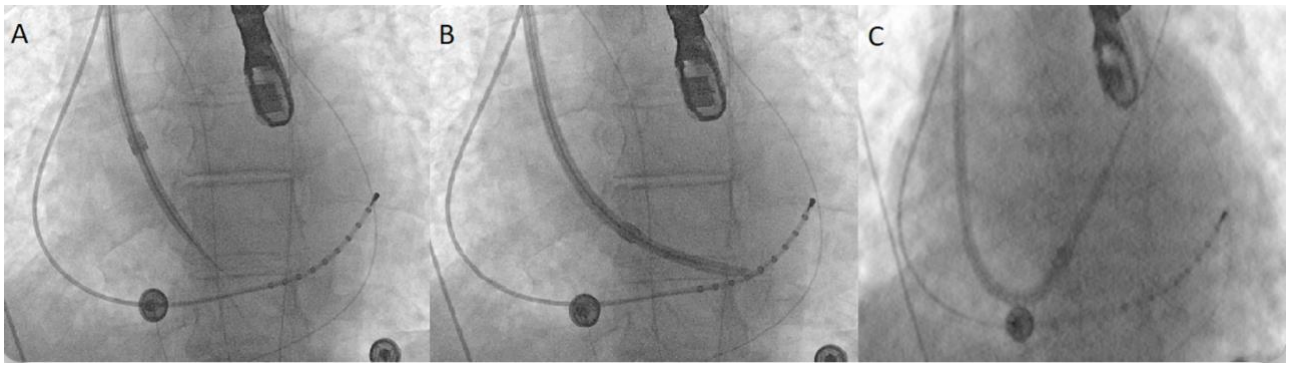
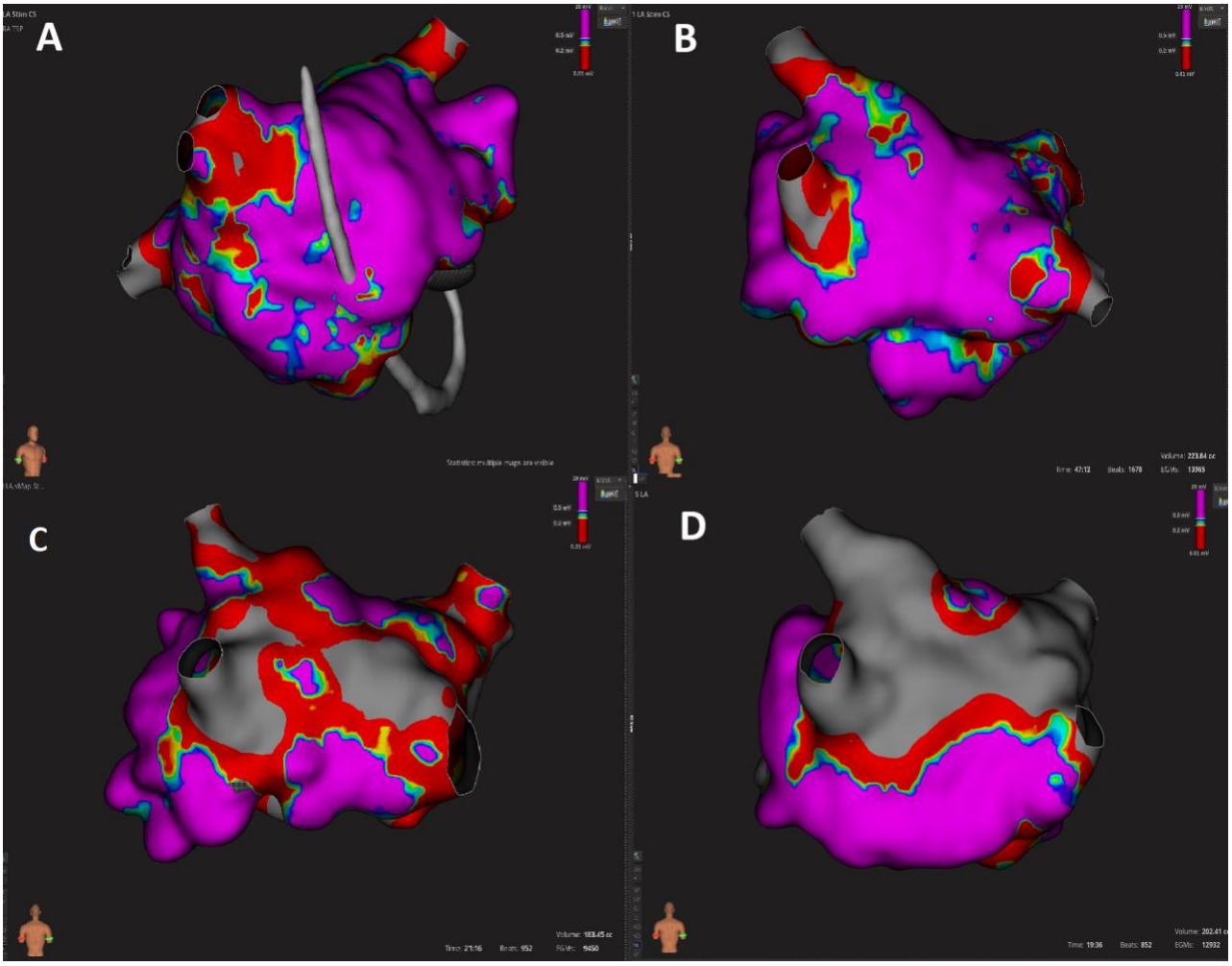


Figure 1: Successful transseptal puncture with fluoroscopy and TOE guidance.

Panel A: Fluoroscopic anterior view with the decapolar catheter in coronary sinus and the FaraDrive sheath with BRK needle at the time of successful transseptal puncture; **Panel B:** Successful transseptal passage of the sheath; **Panel C:** wire placement in the LSPV and further passage of the steerable sheath into the LA.



Central illustration: Results of 3D mapping using Opal HDx.

Panel A: Right anterior oblique view (RAO) of the left atrium (LA) after first mapping with anatomic location and direction of transseptal puncture; **Panel B:** Posterior view of the LA after first mapping showing an electrically intact posterior wall; **Panel C:** Posterior view after first application of PFA and exit block showing large scar areas on the posterior wall and conduction into the RSPV and LSPV; **Panel D:** Posterior view of the LA after successful isolation of all PVs as well as the posterior wall.

Afterwards the multipolar mapping catheter (ORION basket catheter, Boston Scientific, MA, USA) was advanced into the LA and after single direct current electrical cardioversion a 3D electroanatomical map of the LA and the ostia of the pulmonary veins was performed employing the Opal HDx mapping system (Boston Scientific, MA, USA). The LA proved to be enlarged (223 cm^3), the left-sided veins were widely separated, creating a large carina area. The posterior and anterior wall were electrically intact. The FaraWave PFA-catheter (31 mm, 115 cm, Boston Scientific, MA, USA) was advanced into the LA and PFA ablation was performed according to manufacturer's recommendation (four applications in „basket“ configuration and four in „flower“ configuration) with an adapted regimen by ablating additional four times with the catheter in an elongated „olive“-configuration [7]. Between every two applications the catheter was rotated for 30-40°.

Due to persisting signals inside the veins, the right superior pulmonary vein (RSPV) received eight additional applications (four in "basket" and four in "flower" configuration), the left inferior pulmonary vein (LIPV) received two additional applications (two in "basket" configuration) and the right inferior pulmonary vein (RIPV) received two additional applications (two in "olive" configuration). We then applied a total amount of six applications in "flower" configuration to the carina (four septal and two lateral). Exit block of all PVs was demonstrated by pacing via the ablation catheter from the ostia of each vein. We then performed a 3D remap of the LA. Surprisingly, there was still conduction into both the superior veins with gaps localized in the anterior superior part of the veins. The posterior wall showed extensive low-voltage areas by the previous ablation. It was then decided to fully ablate the posterior wall to avoid "lesion set atrial tachycardia" as previously described [8]. Both the RSPV and left superior pulmonary vein (LSPV) received additional eight PFA applications each (four applications in „basket" configuration and four in „flower" configuration). The posterior wall received four PFA applications in "flower"-configuration. A second remap found the posterior wall as well as the LSPV isolated with remaining conduction into the RSPV anterior superior. The RSPV received additional four PFA applications in a modified intermediate configuration between "flower" and "basket" to maximize tissue contact in the anterior part of the ostium. A final remap then confirmed successful isolation of all PVs and the posterior wall. Total procedure time amounted to 288 min with total fluoroscopy time of 48 min (8.48 Gy/cm²). The total amount of PFA applications was 90. The activated clotting time was maintained at >300 s during the procedure. A figure-of-eight suture closed the two punctures after a failed attempt for vascular closure with the PercloseTM ProStyle system (Abbott Cardiovascular, MN, USA). Pericardial effusion was excluded by transthoracic echocardiography.

The patient was taken to the chest pain unit and monitored for seven days. Due to the high number of PFA applications, we screened for hemolysis and acute kidney injury. Creatinine initially rose from 1.34 mg/dl (eGFR 59 ml/min) to 1.58 mg/dl (eGFR 38 ml/min) three days after ablation, then almost completely recovered to 1.44 mg/dl (eGFR 54 ml/min) after 6 days. The haemoglobin remained constant during the seven-day follow-up.

Discussion

To our knowledge, this is the first report of a PVI by PFA with the use of a 3D mapping system via superior access and transseptal puncture directly with the steerable PFA sheath. Catheter positioning at the ostia of the veins with good tissue contact was challenging in this unconventional setting. The additional use of a 3D map helped us overcome this caveat especially in the anterior superior parts of the RSPV and LSPV. Despite being able to demonstrate exit block after the first ablation there were still gaps detectable with the mapping system in the superior veins. Additionally, we were able to identify potential extra-PV substrate and apply further applications of PFA to the posterior wall, albeit the evidence of improved outcomes with ablation outside the PVs is scarce. Transseptal puncture with the steerable FaraDrive sheath from a superior access is challenging but feasible with TOE guidance. Procedure time and fluoroscopy time were quite considerably longer than usual in our lab mostly due to the transseptal puncture and multiple remaps. Still we feel this system is a better choice for PVI than other single shot systems like the cryoballoon, because there is the additional option to treat the posterior wall. This is in line with the very recent FDA approval of the FaraWave system for posterior wall box isolation in July 2025.

Conclusion

PFA ablation for PVI using a pentaspline catheter through a jugular access is a feasible procedure, albeit with more fluoroscopy and a substantially longer procedure time. Catheter positioning according to the manufacturers recommendation is challenging which may impede outcomes. By using a 3D mapping system, we could detect gaps after initial ablation although exit block was present. We also obtained relevant information about LA substrate, which led to posterior wall box isolation. In conclusion 3D mapping was beneficial and should be encouraged in this unusual LA access scenario.

Learning Points

- Transseptal puncture with the steerable PFA-sheath (FaraDrive) by Boston Scientific is feasible in a superior access route setting.
- 3D mapping provided additional information about LA substrate which led to further PFA ablation and would have otherwise been missed.
- 3D mapping provided proof of remaining PV conduction despite being able to demonstrate exit block for all veins before remapping.
- When performing PFA ablation, a high total number of PFA applications is connected to a (transient) decline in renal function.
- When performing PFA ablation with a single shot catheter from a superior access, stable catheter positioning with adequate tissue contact is challenging especially in the superior anterior part of the LSPV and RSPV.

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