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SUCCESSFUL SLOW PATHWAY MODIFICATION WITH RADIOFREQUENCY ABLATION IN A PATIENT WITH AVNRT AND CONGENITAL IVC CONTINUITY WITH AZYGOS VEIN

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ABSTRACT

Background: Congenital anomalies of the inferior vena cava (IVC), such as interrupted or azygos continuation, complicate catheter-based procedures like atrioventricular nodal reentrant tachycardia (AVNRT) ablation. Understanding IVC variations is crucial for successful outcomes in interventional cardiology.

Case presentation: A 57-year-old male with long-standing paroxysmal atrial fibrillation (AF) underwent successful catheter ablation for AVNRT. Intra-procedurally, a congenital IVC anomaly was identified, requiring modified vascular access.

Conclusion: Recognizing IVC anomalies and adapting access strategies are key to overcoming procedural challenges and ensuring successful ablation outcomes. Comprehensive imaging and planning are vital for managing patients with IVC variations.

KEYWORDS

Radiofrequency ablation, supraventricular tachycardia, catheter ablation, cardiac electrophysiology, AVNRT

LEARNING POINTS

- Congenital inferior vena cava (IVC) anomalies, including azygos continuation, can complicate catheter-based interventions such as ablation of atrioventricular nodal reentrant tachycardia.
- Congenital anomalies of IVC are rare but critical considerations for atrioventricular nodal reentry tachycardia (AVNRT) ablation procedures.
- Understanding these variations is essential for ensuring successful catheter-based interventions and minimizing the risk of complications.

INTRODUCTION

The inferior vena cava (IVC) is the primary vein responsible for returning blood from the lower body to the heart. Congenital anomalies of the IVC result from abnormal development during embryogenesis and are often identified incidentally on imaging or during invasive procedures[1].

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During the fourth week of embryonic development, the venous system begins to form through three pairs of veins: the vitelline veins, which drain the yolk sac; the umbilical veins, which carry blood from the placenta; and the cardinal veins, which drain the embryo's body. As the fetus develops, these venous systems undergo a complex process of anastomosis and regression to create mature venous circulation, including the IVC. If these developmental processes are incomplete or abnormal, congenital anomalies of the IVC may result[2].

One such anomaly is azygos continuation of the IVC, which occurs when there is a failure in the formation of the right subcardinal-hepatic anastomosis - the connection that normally allows blood from the lower body to flow directly into the hepatic segment of the IVC and then to the right atrium. As a result, the right subcardinal vein regresses, and venous blood is rerouted through an alternative pathway. This involves shunting blood from the supra-subcardinal anastomosis into the azygos vein, which then continues superiorly into the thorax, ultimately draining into the superior vena cava (SVC). While the hepatic segment of the IVC is typically preserved, the infrarenal and renal segments connect to the azygos system rather than following the normal venous route[2,3].

Congenital IVC anomalies, including azygos continuation, can complicate catheter-based interventions such as ablation of atrioventricular nodal reentrant tachycardia (AVNRT), making pre-procedural recognition critical[4,5]. Failure to recognize these anomalies can lead to serious procedural challenges, including difficulty advancing catheters, misplacement of leads, increased risk of vascular injury, and thrombotic complications. Pre-procedural identification of these variants is essential to prevent failed interventions and optimize patient outcomes. AVNRT, one of the most common forms of supraventricular tachycardia (SVT), is often treated with catheter ablation, highlighting the importance of understanding IVC anatomy for procedural success[6].

The following case illustrates a unique presentation of azygos continuation of the IVC in a patient undergoing catheter ablation for AVNRT, highlighting several procedural challenges. These include difficulty obtaining venous access via traditional femoral routes, the need for advanced imaging (e.g., CT or MR venography) to fully delineate venous anatomy, and the necessity for alternative access strategies, such as via the internal jugular vein[7,8]. Early recognition of IVC anomalies is critical for preventing procedural complications, minimizing radiation exposure, and optimizing patient outcomes

CASE PRESENTATION

We present a case of a 57-year-old male with history of mitral valve prolapse, and long-standing paroxysmal atrial fibrillation (AF) and multiple cardioversions, totaling approximately 12 over the past 25 years. His most recent cardioversion occurred over one year ago, following a stable 5-year period of sinus rhythm.



Figure 1. CT: Venous phase showing hepatic vein draining directly into the right atrium.

Subsequent evaluation indicated a recurrence of arrhythmia. Inducible supraventricular tachycardia (SVT) was noted at a cycle length of 260 ms, raising the possibility of either AVNRT or atrial tachycardia (AT) over a long AH interval.

On follow-up visit, the patient reported experiencing intermittent palpitations several times daily, accompanied by persistent fatigue. Importantly, he denied chest pain, shortness of breath at rest, dizziness, lightheadedness, or syncope.

The patient initially underwent catheter ablation for symptomatic supraventricular tachycardia, during which a congenital inferior vena cava (IVC) anomaly with azygos continuation was identified intra-procedurally using intracardiac echocardiography (ICE) and confirmed with femoral venography. Vascular access was achieved via the left femoral vein, utilizing an azygos approach for ICE and coronary sinus catheter placement, and a small-caliber vein draining into the right atrium to facilitate transseptal access. Pulmonary vein isolation (PVI) was successfully performed using wide antral circumferential ablation (WACA) guided by a 3D electroanatomic mapping system (Carto™, Johnson & Johnson), with confirmed entrance and exit block maintained after adenosine challenge. A CT abdomen and pelvis with IV contrast, obtained four months later, confirmed azygos continuation of the IVC with a retroaortic left renal vein communicating with the azygos system *(Fig.*

1). Due to recurrent symptomatic tachycardia, the patient underwent a second procedure for AVNRT ablation, with vascular access via the right femoral and right internal jugular veins. Electrophysiological testing confirmed typical slow-fast AVNRT, which was successfully treated with targeted radiofrequency ablation of the slow pathway using a non-irrigated catheter. Post-ablation testing showed no inducible arrhythmia, and both procedures were completed without complications.

Post-ablation, the electrophysiology team recommended that the patient undergo implantable loop recorder (ILR) implantation to monitor for VT due to the presence of mitral valve prolapse and mitral valve disjunction. He was also advised to continue taking aspirin 81 mg daily without interruption for the next month. He was monitored on telemetry while awaiting ILR implantation. Following the successful placement of the ILR, the patient was cleared for discharge.

DISCUSSION

The inferior vena cava (IVC) is the primary conduit for blood returning from the abdomen, pelvic viscera, and lower extremities to the right atrium. Although rare, congenital IVC anomalies are important pre-procedural considerations for interventional procedures. There are eight recognized IVC variations, with the most common including interrupted IVC with azygos or hemiazygos continuation, left-sided IVC, and double IVC[3]. The presence of IVC anomalies complicates vascular access, necessitating a modified procedural approach.

In our patient, congenital IVC with azygos continuation was identified intra-procedurally using intracardiac echocardiography (ICE). This anatomical variation required an alternative vascular access strategy, achieved via the left femoral vein and an azygos approach. Several techniques have been documented to facilitate right atrial access in patients with venous anomalies, including the azygos vein extension via femoral puncture[9]. In cases where the femoral approach is not feasible, a superior approach using transjugular access can be employed to puncture the septum and access the left atrium (LA) for pulmonary vein isolation[10].

Despite the challenges posed by IVC anomalies, AVNRT ablation can still be successfully performed with careful preprocedural planning and imaging[4,8]. The successful outcome in this case highlights the efficacy of radiofrequency ablation, even in the presence of significant anatomical variations. Continuous monitoring via an implantable loop recorder (ILR) post-ablation allows for ongoing assessment of arrhythmia recurrence and guides further management if needed.

CONCLUSION

Congenital anomalies of the IVC are rare but critical considerations for AVNRT ablation procedures. Understanding these variations is essential for ensuring successful catheter-based interventions and minimizing the risk of complications[1,5]. This case emphasizes the importance of comprehensive imaging and careful planning in the management of patients with congenital IVC anomalies.

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