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ORIGINAL ARTICLE

The prevalence of superior vena cava anomalies as detected in cardiac implantable electronic device recipients at a tertiary cardiology centre over a 12-year period.

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Abstract *Introduction:* The vast majority of cardiac implantable electronic device (CIED) recipients require transvenous lead insertion, which may be hindered by the presence of venous anomalies. The aim of this study was to determine the prevalence and variations of persistent left superior vena cava (PLSVC) and to conduct subsequent outpatient follow-up in terms of device function and the clinical condition of the recipients using data from CIED placement procedures conducted over a 12-year period.
Methods: The study population included patients undergoing first-time transvenous implantation of cardiac pacemakers and implantable cardioverter-defibrillators (ICDs). The presence of PLSVC was determined based on intra-procedure venography. Outpatient follow-up involved assessments of patient condition, radiological imaging, and CIED function.
Results: Of a total of 4708 CIED recipients, PLSVC was detected in eight patients (mean age 65.5 ± 13.9); five of them had double superior vena cava (DSVC), including three cases in which the vessels were bridged with a brachiocephalic vein (BCV). Three patients presented PLSVC associated with the absence of the right superior vena cava (RSVC), a very rare anomaly. Seven patients remain under observation, for a total of 78.4 ± 48.4 months of follow-up.
Conclusions: The rate of venous anomalies in the form of PLSVC detected in the evaluated population was 0.17%. These PLSVC cases were asymptomatic, which hindered their earlier

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detection. The presence of these anomalies made the procedures more challenging for the operator and increased the perioperative complication rates; however, neither patient condition nor CIED function was affected based on the long-term outpatient follow-up.

1. Introduction

Currently, the most common permanent cardiac pacing technique involves transvenous placement of cardiac pacemakers and implantable cardioverter-defibrillators (ICDs). Cardiac lead insertion is determined by both patency and favourable layout of the venous vascular system from the lead insertion site to final lead placement within the heart.[1,2] Intra-procedure detection of venous system variations that deviate from their typical anatomical layout may sometimes significantly affect the course of the procedure.[3–6] Unless such systemic vein anomalies co-occur with other clinically apparent congenital heart defects,[7] they typically remain undetected until certain cardiological and anaesthesiological procedures or diagnostic assessments are conducted for other reasons.[8–12]

The venous anomalies discussed here were diagnosed based on intra-procedure contrast-enhanced imaging revealing the presence of persistent left superior vena cava (PLSVC). Intra-procedure venography still remains the "golden standard" in venous diagnostics because it helps visualize vascular layout and morphology and helps determine the nature of the anomaly, which facilitates the selection of the optimal route of cardiac lead placement within the chambers of the right heart.[13] The goal of this study was to determine the prevalence and variants of PLSVC in cardiac electronic implantable device (CIED) recipients. The follow-up was conducted in an outpatient setting over a 12-year period and focused on the direct effects of the presence of PLSVC on the course of the procedure as well as on CIED function.

2. Methods

A total of 4708 CIED (i.e., cardiac pacemaker and ICD) recipients who underwent transvenous implantation between January 1, 2003, and December 31, 2014, were included in the study.

CIEDs were implanted in the infraclavicular region, and cardiac leads were inserted either via the cephalic vein (CV) cutdown and/or axillary vein (AV)/subclavian vein (SV) puncture approach. The cause of lead insertion difficulties and/or unusual lead position was investigated using contrast administration into the CV or directly into the AV or SV. Intra-procedure measurements of pacing parameters, such as action potential amplitude, stimulation threshold at a pulse duration of 0.5 msec and pacing impedance, were taken with device-specific readers. Post-procedure follow-up was continued in an outpatient setting and included periodic assessment of device function, location, and immediate surroundings, as well as the patient's clinical status.

3. Results

During the evaluated period, CIEDs were implanted transvenously in 4708 patients, 52% of which were female. In 97% of cases, the procedure was conducted via venous access from the left infraclavicular region. PLSVC was revealed in eight patients, including five women and three men, which constituted 0.17% of the study population (Table 1).

The PLSVC patient group included three different morpho-anatomical subtypes of this venous anomaly:

— three patients (cases number 1, 4, and 7) were diagnosed with double superior vena cava (DSVC) with a developed patent left brachiocephalic vein (LBCV) bridge connecting both vessels (Fig. 1)

— two patients (cases number 2 and 3) had DSVC without a brachiocephalic vein (BCV) bridge (Fig. 2)

!— three patients (see case reports 5, 6, and 8) had a single superior vena cava (SSVC), which is a PLSVC in the absence (agenesis) of the right superior vena cava (RSVC) (Fig. 3).

All of these PLSVC patients eventually received three single-chamber cardiac pacing systems, including one atrial (AAI type device — case 1) due to sinus node dysfunction and two ventricular (VVI type devices — cases 3, 6, and 7) due to third-degree (complete) atrioventricular block with sinus rhythm and chronic atrial fibrillation; in addition, four dual-chamber pacemakers (DDD type) were implanted due to tachycardia-bradycardia syndrome (cases 2 and 4) or complete atrioventricular block with sinus rhythm (cases 5). One patient (case 8) received an ICD-VR for the secondary prevention of ventricular tachycardia.

Venography conducted in three patients (cases 1, 4, and 7) because of an unusual course of the procedures (leads inserted through the PLSVC and the coronary sinus into the right atrium were unintentionally introduced into the RSVC) revealed the presence of DSVC with BCV, with contrast administration showing the precise layout of these vessels. In two patients (cases 2 and 3), the presence of DSVC without BCV was confirmed, independent of intra-procedure venography, via computed tomography angiography (CTA). A previous CTA performed in one patient (case 8) provided information about the presence and the type of LSVC prior to the procedure, which was confirmed via intra-procedure venography. In two patients (cases 5 and 6), lead position during lead introduction suggested the presence of PLSVC, and intra-procedure venography showed a lack of