First rib and venous anomalies — Anatomical challenges for transvenous implantation of cardiac electronic devices

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A B S T R A C T
Atypical anatomy may be encountered unexpectedly and undiagnosed in clinical practice, and this is especially important during the performance of interventional procedures such as transvenous implantation of cardiac electronic devices. The body of the first rib can be absent. If this not noticed, pneumo-/haemothorax may be induced during subclavian vein puncture as the needle may enter the first intercostal space rather than the costo-clavicular angle. The cephalic vein may pursue a supraclavicular course, the axillary vein may drain into an intercostal vein rather than the axillary vein, and the entire length of the axillary-subclavian-brachio-cephalic vein may be absent. Device implanters should be vigilant about the possibility of these anatomical variations, and be equipped with the knowledge and spectrum of alternative techniques needed to deal with them.

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1. Case description
A 79 year old man developed cardiac tamponade with loss of ventricular capture in the middle of the night after routine left-sided dual chamber pacemaker implantation for complete heart block the day before. The duty device physician, who was not the original implanter, performed emergency pericardiocentesis and temporary pacing wire insertion and the patient stabilized. The duty physician decided to replace rather than reposition the dislodged ventricular lead as he was concerned its fixation helix might be embedded in either myocardium or a thrombus. The record of the original implantation stated the left cephalic vein was not found and central venous access was achieved by direct puncture. The duty physician decided to re-puncture the left axillary-subclavian vein under fluoroscopic guidance [1] but bulked at the first image he saw (Fig. 1). What did he notice?

2. Discussion
The most cranial rib body was more caudal than expected and was joined to 2 heads dorsally (Fig. 1). The duty physician surmised the left first rib might have no body and its head was fused with the body of the left second rib (i.e. congenital synostosis — a rare but recognized anatomical anomaly that may cause neurovascular compromise in the thoracic outlet syndrome) [2–5]. He was unable to puncture the axillary vein by targeting the needle at the existent leads. Retrograde venography from the right femoral vein showed

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Fig. 1. Fluoroscopic image of the left pectoral region in the postero-anterior projection with a slight caudal tilt. The most cranial rib body belonged to the second rib and was joined to not only the head of the second rib, but also that of the first rib (i.e. synostosis of the left first and second ribs).
The superior vena cava (SVC) was joined on the left by only the azygos vein but not the left brachio-cephalic vein (absent), and the existent leads directly entered the SVC (Fig. 2b). Anterograde venography from the antecubital fossa showed the basilic vein drained medially and dorsally into the left second intercostal vein (visible as the large top branch of the azygos vein in Fig. 2b) but not the axillary-subclavian vein (absent). The cephalic vein took a supraclavicular course and was small and tortuous. On both sides, the first rib was absent and the most cranial rib body belonged to the second rib.

The supraclavicular course explained why the left cephalic vein was not identified during the original implantation. Lead implantation through the small and tortuous left cephalic vein would be difficult and unlikely to be successful [6]. Puncturing the SVC from the left infra-clavicular fossa (following the course of the existent leads) would involve passing the needle for a long distance medially through an expanded gap including the first intercostal space as well as the costo-clavicular angle, and subject the recently stabilized patient to an elevated but largely unknown risk of pneumothorax. For these reasons, the duty physician decided to explore the right upper body veins. The right axillary vein was identified with retrograde venography (Fig. 2a) and successfully punctured fluoroscopically [7]. The right first rib body was also incidentally noticed to be absent and the most cranial rib body belonged to the right second rib.

A new pacemaker system was implanted on the right, the left-sided device pocket was closed up, and the temporary pacing wire removed. An urgent CT scan of the thorax the next morning confirmed synostosis of the first and second ribs on the left and a hypoplastic first rib on the right (Fig. 3). As there was no evidence of pneumothorax or any communication between the SVC and the left pleural cavity, the left-sided pacemaker system (including the leads) was explanted completely. The patient made an uneventful recovery and was discharged home a week later. Prior to pacemaker implantation, the patient never had any symptoms from his skeletal anomaly, which remained undiagnosed.

Atypical anatomy may be encountered unexpectedly and undiagnosed in clinical practice. Physicians performing interventional procedures should be vigilant about the possibility of anatomical variations, and be equipped with the knowledge and spectrum of alternative techniques needed to deal with them [8].

**Conflicts of interest**

EWL consultancy for Abbott.

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