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CLINICAL RESEARCH

Supraclavicular vein approach to overcoming ipsilateral chronic subclavian vein obstruction during pacemaker–ICD lead revision or upgrading

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Aims We report our experience with the supraclavicular vein approach of subclavian vein puncture to overcome ipsilateral chronic obstruction when implanting pacemaker or implantable cardioverter defibrillator leads.

Methods and results The subclavian vein obstruction was documented by venography. The skin was punctured with an 18-gauge needle, 1 cm lateral to the lateral head of the sternocleidomastoid muscle and 1 cm cranial to the clavicle. The needle was directed under and close to the clavicle pointing to the sternal notch. Once the vein was successfully punctured, medial to the obstruction, a 0.38 in. guidewire was inserted into the venous bed. A peel-away sheath was indwelled using the Seldinger technique. The leads were placed in the standard fashion; they were secured by suture to the subcutaneous tissue of the fossa supraclavicularis major using a protective sleeve. The proximal portion of the lead was tunnelled over the clavicle down to the device's prepectoral pocket. Lead insertion was performed in four patients (twice in one patient) with total left subclavian vein obstruction; the site of the obstruction was in the mid-segment of the left subclavian vein in two patients, in the axillary and distal segment of the subclavian vein in one patient, and in the distal segment of the subclavian vein in one patient. There were no complications with the surgical wound and the lead parameters remained stable.

Conclusion The supraclavicular approach of the subclavian vein puncture to overcome ipsilateral total occlusion is feasible and safe.

Keywords Subclavian vein obstruction • Supraclavicular subclavian vein approach • Lead revision • Pacing system upgrading

Introduction

Significant vein occlusion was found in 25% of patients after placement of implantable cardioverter defibrillator (ICD)[1] and in 27% of patients after pacemaker implantation,[2] and the subclavian vein was the most frequently occluded. Subclavian vein occlusion may be an incidental finding as well, found in 1 of 154 (0.6%) patients who underwent venography before upper extremity placement of peripherally inserted central venous catheters.[3] In addition, central venous stenosis was found in 10% of hemodialysis patients with no previous history of catheter placement.[4] Total subclavian vein occlusion is rarely symptomatic; however, it represents a difficult obstacle when system upgrading or lead revision is performed using the ipsilateral subclavian vein.

We describe our experience with the ipsilateral supraclavicular approach of the subclavian vein to overcome its obstruction as an alternative technique for lead implantation.

Methods

The subclavian vein occlusion was documented by venography, which is performed routinely before new lead implantation in all patients with leads previously implanted in the ipsilateral vein system or after failure to advance a guidewire intravascularly.

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The patient was asked to lay flat, with head turned slightly to the contralateral side. The clavisternomastoid angle (the junction of the clavicular head of the sternocleidomastoid muscle with the clavicle) was identified. In obese patients, the lateral border of the clavicular head of the sternocleidomastoid muscle is more easily identified by active elevation of the patient's head. Cephamezin (1 g) was administered intravenously before beginning the procedure.

After asepsis of the infraclavicular, jugular and pectoral area, and local anaesthesia, a 2 mm skin incision was performed 1 cm lateral to the lateral head of the sternocleidomastoid muscle and 1 cm cranial to the clavicle; an 18 gauge 7 cm needle with attached syringe was advanced through the incision, directed closely under the clavicle and pointing to the sternal notch, slowly and with constant negative pressure in the syringe (*Figure 1*). Once the vein was successfully punctured medially beyond the obstruction, a 0.38 in. guidewire was inserted into the venous bed under fluoroscopic vision and the needle withdrawn (*Figure 2*).

A 2 cm long supraclavicular skin incision, running parallel to the clavicle down to the subcutaneous tissue, was made across the site of the percutaneous wire entry. A peel-away sheet was then indwelled using the Seldinger technique. The leads were placed according to standard methods; they were secured by suture to the subcutaneous tissue of the fossa supraclavicularis major using a protective sleeve (*Figure 3*). The proximal portion of the lead was subcutaneously tunnelled over the clavicle down to the device's prepectoral pocket and connected to the generator. The skin incisions in the supraclavicular region and over the device pocket were closed in layers.

Results

Lead insertion by supraclavicular approach through the ipsilateral occluded left subclavian vein was performed in four patients (twice in one patient), mean age 64.6 $\pm$ 10.6 years. Three patients had a previously implanted ICD, and in one it was the first ICD implant.

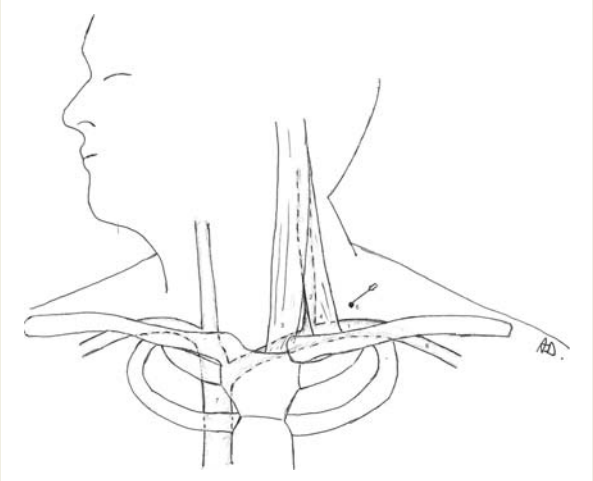

Figure 1 Relevant anatomical structures in the supraclavicular approach for subclavian vein puncture. 1, subclavian vein; 2, internal jugular vein; 3, sternal head of the sternocleidomastoid muscle; 4, clavicular head of the sternocleidomastoid muscle; 5, point of needle insertion; 6, axillary vein; 7, superior vena cava.

The site of the obstruction was in the mid-segment of the left subclavian vein in two patients, in the axillary and distal segment of the subclavian vein in one patient, and in the distal segment of the subclavian vein in one patient. Collateral circulation was seen in all venograms. All patients were asymptomatic. The patients' characteristics are summarized in *Table 1*. All of the leads were

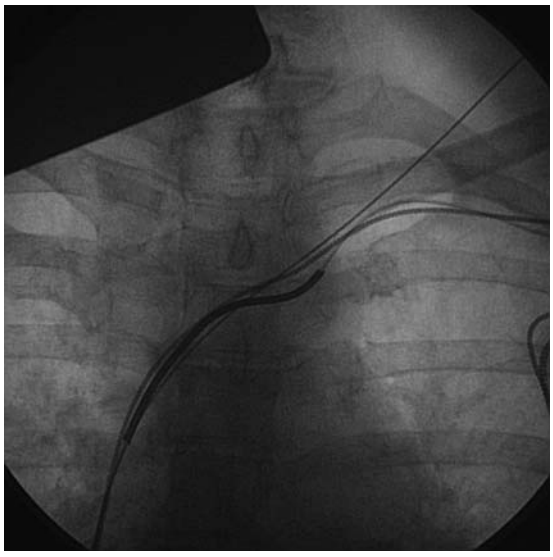

Figure 2 Intraoperative chest radiograph (Patient 3). A 0.38 in. guidewire is inserted into the venous bed under fluoroscopic vision in the right atrium and the needle is withdrawn.

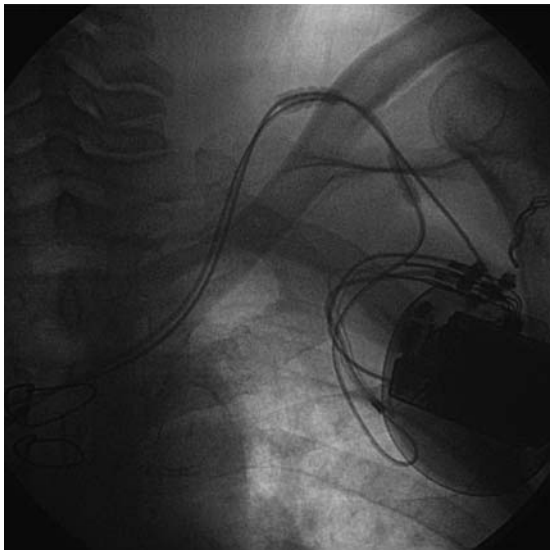

Figure 3 Postoperative chest radiograph (Patient 4). The leads are secured by suture to the subcutaneous tissue of the fossa supraclavicularis major using a protective sleeve; they are subcutaneously tunnelled over the clavicle and connected to the generator in the prepectoral pocket.

Table 1 Patient characteristics

Patient no.	Gender	Age (year)	Previous device	Type of intervention	Reason for intervention	Leads inserted	Site of vein occlusion	Follow-up duration (year)	Heart disease
1	M	76	ICD–VVI	Upgrading to ICD–DDD	Pacemaker Syndrome	Atrial	Mid left subcl. vein	4[a]	S/P MI
2	M	1st: 52	ICD–DDD	Upgrading to CRT-D	Worsening CHF	LV lead	Left axillary-distal subclavian vein	2	S/P MI
		2nd:54	CRT-D	Replacing defibrillation lead	Inappropriate shocks-damaged lead	Defibril. lead		1.5	
3	F	68	ICD–DDD	Replacing defibrillation lead	Inappropriate shocks-damaged lead	Defibril. lead	Distal left subclavian vein	1.5	CM
4	M	72	–	ICD implantation	Sustained VT	Atrial + defibril. lead	Mid left subclavian vein	1	S/P MI and CABG

ICD, implantable cardioverter defibrillator; VVI, VVI pacing; DDD, DDD pacing; CRT-D, cardiac resynchronization therapy-defibrillator; S/P MI, state post-myocardial infarction; CHF, congestive heart failure; VT, ventricular tachycardia; CABG, coronary artery bypass graft; Defibril., defibrillation; subcl., subclavian.
[a]Deceased.

tunnelled over the clavicle and all of the devices were prepectorally implanted.

During a mean follow-up of 2 years, the patients had no complaints and the lead parameters remained stable.

Discussion

The infraclavicular subclavian route is commonly used for insertion of permanent pacemaker–ICD leads. However, in the presence of venous obstruction, the ipsilateral vein cannot be used for the system's revision or scheduled upgrade. Consequently, a variety of different strategies to overcome the venous obstruction have been reported.[4–11] Of these, we favoured the supraclavicular ipsilateral subclavian vein approach because this technique permits overcoming the subclavian vein occlusion by puncturing the vein medial to it and this seemed to be the simplest of the reported methods.

First introduced by Yoffa,[12] the supraclavicular approach of the subclavian vein was used for central vein catheterization; the safety and feasibility of this procedure has been recently emphasized.[13,14] This technique has also been successfully used for temporary pacemaker implantation.[15,16]

Ovadia *et al.*[17] used the left supraclavicular subclavian vein approach in four children and one adult patient and concluded that this technique would have the greatest application in the adult population. Liu *et al.*[18] used the right supraclavicular subclavian vein approach for permanent pacing in 44 patients and concluded that it is a safe and reliable alternative to the infraclavicular route. Our first two cases, reported previously,[19,20] demonstrated the safety and feasibility of the technique.

In our post-coronary artery bypass graft patient, a left axillary and distal subclavian vein occlusion was incidentally found at the time of ICD implantation: in this case, we preferred to implant the ICD in the ipsilateral pectoral region because of higher defibrillation threshold and a near doubling of all-cause mortality rate among patients with right compared with left pectoral implants.[21]

Part of the operative technique is the tunnelling of the electrode. Ovadia *et al.*[17] reported dislodgement of one lead in one of the two children on which supraclavicular tunnelling was used and recommended retroclavicular tunnelling. Liu *et al.*[18] reported no lead dislodgement, fracture, or skin erosion in any of the adult patients that underwent supraclavicular tunnelling, similar to the results seen in our patients. On the basis of these findings, retroclavicular tunnelling may not be advisable in children but it is safe in adults.

We conclude that the supraclavicular approach of the subclavian vein to overcome ipsilateral obstruction is a feasible and safe procedure for pacemaker and ICD lead revision or upgrading.

Conflict of interest: none declared.

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