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Original Article

Variations in cephalic vein venography for device implantation–Relationship to success rate of lead implantation

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ABSTRACT

Introduction: Lead implantation using the cephalic vein (CV) cutdown technique has been well established, but is not always expected to achieve high success rates. We studied the relationship between preoperative CV venography and the success rate of lead implantation.

Methods: Two hundred and twenty one CV venographies were performed in 205 patients (mean age 75 years, 113 males). Leads were inserted via the CV cutdown technique with a guidewire and sheath. Variations in CV venography included usage of the right and left CVs. The success rate of lead implantation was studied.

Results: No major kink was observed in 71% of the right CV cases and 43% of the left CV cases. Leads were successfully implanted in over 90% of these patients. A major kink in the CV was found in 15% of the right CV cases and 34% of the left CV cases and successful lead implantation was around 80% in this population. The overall success rate tended to be higher for the right side (83%) than for the left side (71%).

Conclusion: Severe kinks or variations in the CV that hinder lead manipulation were less frequent in the right CV. Therefore, a higher success rate of lead implantation by the cutdown technique is expected for the right CV.

1. Introduction

Antiarrhythmic device lead implantation using the cephalic vein (CV) cutdown technique is considered to be superior to the conventional subclavian vein puncture method with regards to the incidence of perioperative complications such as pneumothorax [1,2] and lead longevity [3]. However, manipulation of leads is sometimes difficult and results in frequent failure of lead placement [1,4,5] due to a kink in the CV [5].

This study was a retrospective study to define variations in preoperative CV venography and to understand how these variations influence the success rate of lead implantation.

2. Subjects and Methods

2.1. Study subjects

The study subjects consisted of 205 patients in whom antiarrhythmic devices were implanted. The mean age was 75 ± 12 years. There were 113 males and 92 females. A pacemaker was implanted in 162 patients (single/dual chamber: 24/138), an implantable cardioverter defibrillator was implanted in 34 patients (single/dual chamber: 5/29), and a heart failure device with defibrillator was implanted in 9 patients. Underlying heart diseases included coronary artery disease in 38 patients, hypertensive heart disease in 51 patients, dilated cardiomyopathy in 6 patients, hypertrophic cardiomyopathy in 1 patient, and Brugada syndrome in 2 patients. Patients who had a history of open chest surgery, severe emphysema and tuberculosis, and chest wall deformities were excluded from this study.

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2.2. Methods

A venography of the CV was performed and recorded as a cineangiogram at an anterior–posterior view just before device implantation. The CV was enhanced by injecting 10 mL of contrast medium from the peripheral CV. Device implantation was conducted using the standard CV cutdown technique [4] from the enhanced side unless obstacles such as anomalies, obstructions, and very strong kink in the venous route were apparent. Once the CV was isolated, leads were placed employing a guidewire and the peel away sheath technique [5,6]. If the CV isolation or the introduction of the guidewire failed, the operator switched to the subclavian vein puncture method. The variations of CV venography and the success rate in lead implantation on both the right and left sides were studied.

3. Results

CV venography was performed in 205 patients. It was performed from both sides in 16 patients. As a result, 75 right and 146 left CV venographies were performed. According to the

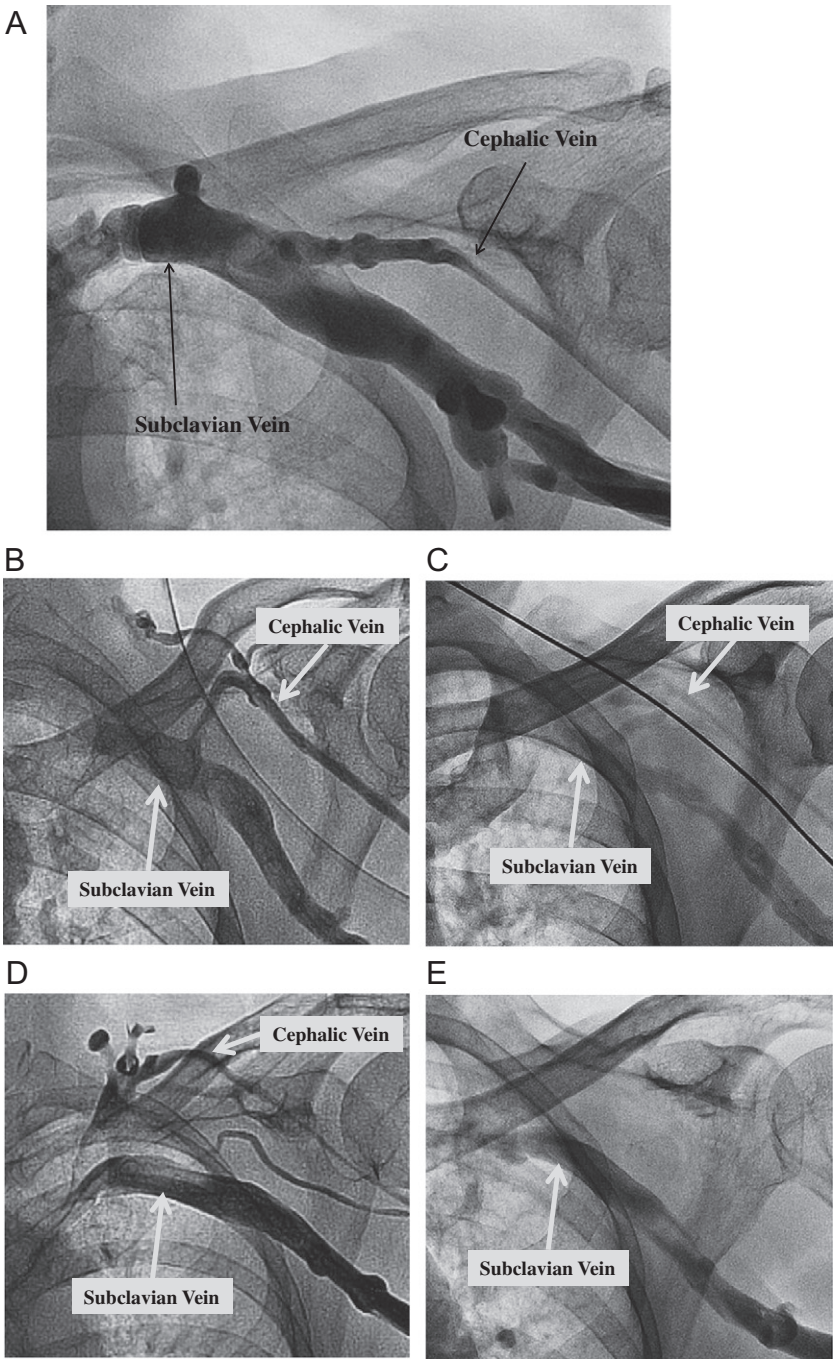

Fig. 1. Classification of cephalic veins (CVs) based on the findings of CV venography. CVs were classified into smooth type, kinked type, and cases with no enhancement of the CV based on the findings of the CV venographies. The kinked type was further divided into L-shaped, sigmoid-shaped, and override the clavicle. The CV and subclavian vein are indicated by arrows. (A) No major kink before running into the subclavian vein in this case (smooth type). (B) A typical example of an L-shaped kink. The proximal CV was shaped like an 'L' because of the kink. (C) A typical example of a sigmoid-shaped kink. Multiple major kinks existed before running into the subclavian vein. (D) Override the clavicle. The CV ran round over the clavicle, then into the subclavian vein. (E) The CV was not enhanced.

findings of the CV venographies, the CVs were classified into smooth type, kinked type, and no enhancement of the CV (Fig. 1). The kinked type was further divided into L-shaped, sigmoid-shaped, and override the clavicle as shown in Fig. 1.

Comparisons between the right and left side CV venographies are summarized in Table 1. In 71% of the right CV venographies and 43% of the left CV venographies, the CV was of the smooth type. The kinked type was less frequently observed in the right CV (15%) as compared to the left CV (35%, $p < 0.05$). The CV was not enhanced in 15% of the right CV venographies and 23% of the left side CV venographies. In the left side venography, persistent left superior vena cava (PLSVC) was found in 2 patients.

Success rates and the reasons for failure in lead implantation upon using the CV cutdown technique in each condition are shown in Tables 2 and 3. On the right side, the success rates in lead implantation were 94% in smooth type CV, 82% in kinked type CV, and 27% in cases with no enhancement of the CV (Table 2). On the left side, the success rates were 92% in smooth type CV, 76% in kinked type CV, and 21% in cases with no enhancement of the CV (Table 3). Regarding the patients with an L-shaped kink in the CV, lead implantation was successful in approximately 90% of these patients. In contrast, passing the guidewire and sheath was extremely difficult in sigmoid-shaped kinks and in an override the clavicle type of CV. Therefore, lead implantation using the CV cutdown technique was unsuccessful in most of these patients. The CV was isolated and lead implantation was successful in only one-third of patients with this condition with no enhancement of the CV because of the failure to isolate or insert the guidewire due to the small size of the vessel. In patients with PLSVC, the device was basically implanted in the right side. The overall success rate in desired lead implantation was around 80%; however, there tended to be a higher success rate on the right side as compared to the left side (83% vs. 71%, respectively).

Table 1
Comparison between the right and left side cephalic vein venography.

	Right ($n=75$)	Left ($n=146$)	p Value
Smooth type	53 (70.7%)	63 (43.1%)	<0.05
Kinked type	11 (14.7%)	50 (34.2%)	<0.05
L shaped	10 (13.3%)	39 (26.7%)[a]	NS
Simiod shaped		5 (3.4%)	NS
Override CL	1 (1.3%)	6 (4.1%)	NS
No enhancement	11 (14.7%)	33 (22.6%)[a]	NS

CL: clavicle.
[a] Including a patient with persistent superior vena cava.

4. Discussion

4.1. Major findings

The major finding of this study was that the left CV frequently showed a noticeable kink, but that such a kink was found less frequently in the right CV. However, lead implantation using the CV cutdown technique was highly successful under the guidewire technique.

4.2. Lead implantation using the CV cutdown technique

Since the peel away sheath was introduced, the subclavian vein puncture method has been widely used for endocardial lead placement for antiarrhythmic device implantation instead of the venous cutdown technique. However, conventional intrathoracic subclavian vein approaches sometimes cause complications such as pneumothorax or hemothorax [1,2,7–9]. In addition, subclavian crush syndrome may cause lead insulation failure and conducting wire fracture because implanted leads usually penetrate the costoclavicular ligament and pectoral muscles in this method [1–3,10]. On the other hand, lead implantation using the CV cutdown technique is considered to be superior in terms of avoiding the above described complications [1–3,6,7]. Despite these advantages of the CV cutdown technique and the introduction of the extrathoracic subclavian vein puncture method, many device implanting physicians perform conventional subclavian vein puncture methods for device lead implantation because of its simplicity and ease [7,8,11]. In fact, we sometimes encounter difficulties in the isolation and venotomy of the CV. If the CV is small and thin, or kinked, lead placement often fails, particularly when inexperienced physicians attend to this technique. The success rate in lead implantation using the CV cutdown technique was reported as approximately 60–75% [1,4–6,11]. The cause of the low lead implantation success rate using this technique has not been well defined although Tse et al., and Rugge et al. suggested that kinks and anomalies in the CV and small vessel size might be major reasons influencing the success of this technique [5,7]. The incidence of kinks and anomalies in the CV is also unknown because preoperative CV venography is not always performed.

This study found that there were variations in the anatomy of the CV. In patients in whom the CV ran smoothly into the subclavian vein, lead implantation using the CV cutdown technique was highly successful unless the CV was not detected or isolated. In one-third of the left CV venographies and 15% of the right CV venographies, the kink that may have interfered with lead placement was identified. L-shaped kinks seemed to be an obstacle to lead implantation, not the CV cutdown technique itself. The guidewire and sheath techniques were apparently

Table 2
Failure reason and success rate in lead implantation in the right side.

	Switched to the left side[a]	Faliure in CV isolation	Faliure in insertion of guide wire or sheath	Failure in placement of second lead[b]	Unsuccess/success [success rate]
Smooth type	1 (1.8%)	–	1 (1.8%)	1 (1.8%)	3/50 [94.3%]
Kinked type	1 (9.1%)	–	–	–	2/9 [81.8%]
L shaped	1 (11.1%)	–	–	–	1/9 [88.9%]
Simiod shaped	–	–	–	–	–
Override CL	–	–	1 (100.0%)	–	1/0 [.0%]
No enhancement	4 (36.4%)	2 (18.2%)	2 (18.2%)	–	8/3 [82.7%]
Overall	6 (8.0)	2 (2.7%)	4 (5.3%)	1 (1.3%)	13/62 [82.7%]

CL: clavicle; CV: cephalic vein.
[a] According to the findings of cephalic vein venography.
[b] Required subclavian vein puncture for the second lead placement.

Table 3
Failure reason and success rate in lead implantation in the left side.

	Switched to the left side[a]	Faliure in CV isolation	Faliure in insertion of guide wire or sheath	Failure in placement of second lead[b]	Unsuccess/success [success rate]
Smooth type	1 (1.6%)	–	2 (3.2%)	2 (3.2%)	58/5 [92.0%]
Kinked type	7 (14.0%)	–	5 (10.0%)	–	38/12 [76.0%]
L shaped	2 (8.7%)[c]	–	1 (16.7%)	–	36/3 [92.3%]
Simiod shaped	2 (40.0%)	–	1 (20.0%)	–	2/3 [40.0%]
Override CL	3 (50.0%)	–	3 (50.0%)	–	0/6 [0.0%]
No enhancement	8 (24.2%)[c]	10 (30.3%)	7 (21.2%)	1 (3.0%)	7/26 [21.2%]
Overall	16 (11.0)	10 (6.8%)	14 (9.6%)	3 (2.1%)	103/43 [70.5%]

CL: clavicle; CV: cephalic vein.

[a] According to the findings of cephalic vein venography.
[b] Required subclavian vein puncture for the second lead placement.
[c] Including a patient with persistent superior vena cava.

helpful, and once a guidewire and sheath were passed into the superior vena cava, lead implantation was successful (Tables 2 and 3). On the other hand, if a sigmoid-shaped kink is detected in the CV or a clavicle override type CV is detected in the preoperative CV venography, the CV cutdown technique should not be selected for lead implantation because successful passing of the guidewire, sheath, and leads is not expected. Another reason for unsuccessful lead implantation using the CV cutdown technique was small size and weakness of the CV. This condition led to difficulty in the detection and venotomy of the CV and insertion of a guidewire and sheath. Especially if the CV was not enhanced, detection of the CV failed in most cases because of poor development of the CV. However, the CV developed normally and the CV cutdown technique was successful in one-fourth of the patients in whom the CV was not enhanced. Therefore, we should be aware that venography cannot always enhance the CV, and that enhancement depends on peripheral venous circulation.

Overall, a trend towards higher overall success rate in lead implantation by the CV cutdown technique was noted on the right side as compared to the left side (83% vs. 71%, respectively). If a shorter operation time is desirable, especially in older patients in whom a high-energy device is not required, the right side approach may be appropriate while using the CV cutdown technique.

5. Conclusion

The presence of major kinks that may interfere with lead manipulation was less frequent in the right CV than in the left CV, and a higher success rate in lead implantation by the CV cutdown technique is expected on the right side.

Conflict of interest

None.

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