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Cephalic vein approach for the implantable central venous access

A retrospective review of the single institution's experiences; Cohort Study

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Abstract

Long-term venous access is usually required in patients receiving chemotherapy. We hypothesized that, out of the various central line approach techniques, the cephalic vein cut-down technique can be a safe and simple alternative in terms of surgical safety, feasibility, cost-effectiveness, and functional outcomes.

We retrospectively reviewed the medical records of 569 patients who underwent implantable central venous access between January 2012 and December 2014 at our hospital.

We classified our cohort according to access routes, as follows: 230 patients underwent subclavian vein access, 134 patients underwent internal jugular vein access, 25 patients underwent external jugular vein access, and 119 patients underwent cephalic vein access. The cephalic vein group had a significantly longer operation time than the subclavian group ($P < .01$); however, there was no difference in operation time between the internal jugular vein and cephalic vein groups ($P = .59$). The procedure-related complications and functional outcomes of the implanted venous port during chemotherapy were comparable between the cephalic group and other groups. Additionally, body mass index, operation time, and age did not correlate with catheter dysfunction in the multivariate logistic regression analysis ($P = .53$; $P = .66$; $P = .19$, respectively).

We suggest that a cut-down central venous catheter insertion through the cephalic vein can be performed easily and safely with no differences in surgical and clinical outcomes compared to those of conventional percutaneous approaches. Moreover, the cephalic vein approach requires no specialized equipment, including percutaneous vascular kits, tunneling instruments, and intraoperative ultrasonography. Therefore, this technique might incur less medical expenses than conventional approaches and would be helpful for both patients and surgeons.

Abbreviations: BMI = body mass index, EJV = external jugular vein, IJV = internal jugular vein, USG = ultrasonography.

Keywords: cephalic vein, feasibility, implantable central venous access, safety

1. Introduction

Safe and reliable venous access is an essential procedure in modern oncology,[1,2] as long-term venous infusion is occasionally required in cancer patients for chemotherapy, fluid resuscitation, and nutritional treatment.[3] Implantable central venous devices can play an important role in minimizing the discomfort of frequent vein puncture and cannulation.[4,5] Recently, the internal jugular vein (IJV) approach using real-time ultrasonography (USG) has gained popularity and has been performed widely; however, this approach might increase patients' discomfort and might cause inconvenience in maintaining an aseptic occlusive dressing.[6] In this study, we aimed to introduce our surgical technique of cephalic venous access and to identify its safety, feasibility, and long-term functional outcomes compared to those of conventional methods. In addition, we investigated the possible risk factors that might affect the dysfunction of the implanted venous port.

2. Materials and methods

2.1. Study design

This study was approved by the institutional review board of Bucheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea (HC19RESI0002). We retrospectively

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reviewed the medical records of patients who underwent implantable central venous access performed by surgeons between January 2012 and December 2014 at our hospital. The cases that were conducted by interventional radiologists were excluded. All patients gave written consent to the procedure and data collection for our database. The data, including patient demographics, cause of catheter insertion, venous approach methods, operation time, length of functional availability, and cause of device removal, were collected and analyzed. We classified our patients into 4 groups according to the venous access routes: IJV approach with real-time USG; external jugular vein (EJV) access with a cut-down method; subclavian vein access with the Seldinger landmark technique; and cephalic vein access. The operation methods were decided randomly according to the surgeons' competence and preference. We compared surgical and clinical outcomes between each group and performed additional analyses to identify risk factors for long-term functional impairment of the implanted venous devices.

2.2. Procedure for the cephalic vein approach

The patient was placed in a supine position, and his/her arm on the side of the procedure was extended to fully expose the outline of the deltoid and pectoralis muscles. After local anesthesia using diluted lidocaine was applied, a skin incision was made in the upper anterior chest wall along the deltopectoral groove (Fig. 1). Sharp dissection was carried out using electrocautery and curved mosquito forceps through the plane between the deltoid and pectoralis major muscles until the cephalic vein was identified (Fig. 2). The cephalic vein was then ligated proximally, and transverse venotomy was performed (Fig. 3), through which the venous catheter was inserted (Fig. 4). After radiologic examination for accurate placement of the catheter tip between the superior vena cava and right atrium, the reservoir was implanted with a suture on the pectoralis fascia (Fig. 5). The final catheter position was checked with a postoperative chest X-ray.

2.3. Statistical analysis

Summary statistics are presented as numbers and percentages for categorical variables and as the mean ± standard deviation for continuous variables. The Chi-square test or Fisher exact test was used to compare categorical variables, and the independent *t* test was used for continuous variables. Univariate and multivariate logistic regression analyses were applied to analyze the correlation of the possible risk factors with delayed malfunction of the implanted venous devices. We considered a 2-sided *P*-value $< .05$ to be statistically significant. All statistical analyses were performed using the software package SAS 9.4 (SAS Institute, Inc, Cary, NC).

Figure 1. Skin incision in the upper anterior chest wall along the deltopectoral groove.

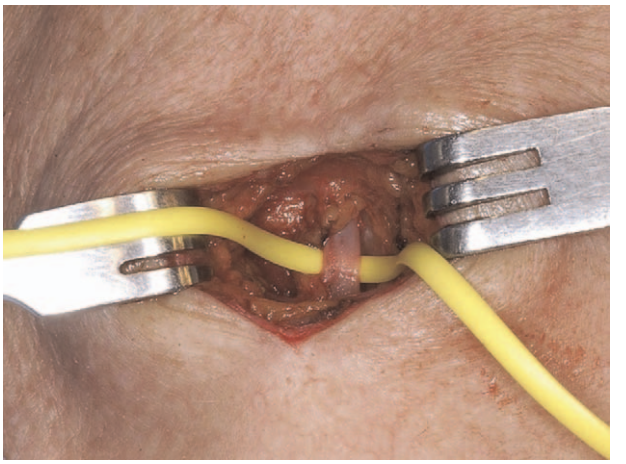

Figure 2. Identifying the cephalic vein.

3. Results

A total of 508 patients were included in this study: 230 patients were included in the subclavian group; 134 in the IJV group; 25 in the EJV group; and 119 in the cephalic vein group. Regarding demographic characteristics (Table 1), the cephalic group had a large portion of the colorectal malignancies compared to that of the IJV and subclavian groups (53.7% vs 34.3%, $P < .01$; 53.7% vs 35.2%, respectively, $P < .01$), and the IJV group included more female patients than the cephalic group (70% vs 57%, $P = .03$). The body mass index (BMI), patient age, and side of the access were similar between the cephalic and other groups. The mean operation time of the entire cohort was 46.9 minutes. The

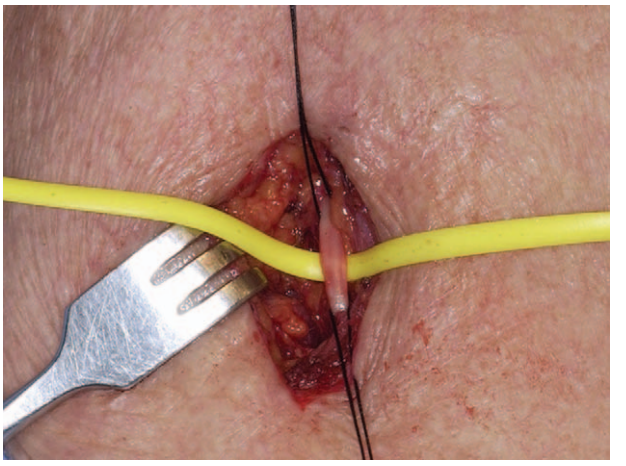

Figure 3. Ligating the cephalic vein at the proximal and peripheral sides.

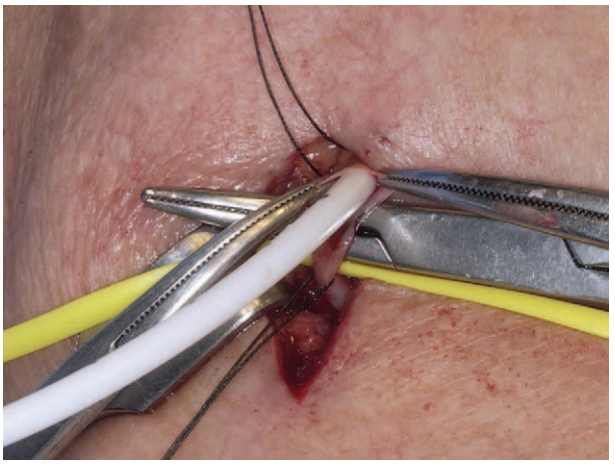

Figure 4. Catheter insertion after transverse venotomy.

cephalic group had a longer operation time than the subclavian group (51.5 minutes vs 38.1 minutes, $P < .01$); however, there was no difference in the operation time between the cephalic and IJV groups (51.5 minutes vs 53.7 minutes, $P = .59$). Comparatively, the operation time was longer in the EJV group than in the cephalic group (69.1 minutes vs 51.5 minutes, $P < .01$). The length of catheter use and cycles of chemotherapy were comparable between the cephalic and other groups. In addition, the incidence of unscheduled catheter removal caused by late complications was similar between the cephalic and other groups as well. Infection and malfunction of the catheter were found to be late complications causing impairment in cyclic chemotherapy. We found 6 cases (1.2%) of immediate complications after the operation: the 4 cases in the subclavian group were all pneumothorax, and the 2 cases in the cephalic group were pneumothorax and postoperative bleeding. The statistical analysis was difficult for a few complicated cases.

Univariate analysis for the risk factors of late complications was performed according to the venous access routes, BMI, operation time, and age; however, the results were nonsignificant: odds ratios were 0.959 for the noncephalic approach ($P = .93$), 1.031 for BMI ($P = .56$), 1.004 for operation time ($P = .64$), and 0.979 for age ($P = .21$). In the multivariate logistic regression analysis (Table 2), no factor was demonstrated to increase the incidence of late complications, including infection and catheter malfunction.

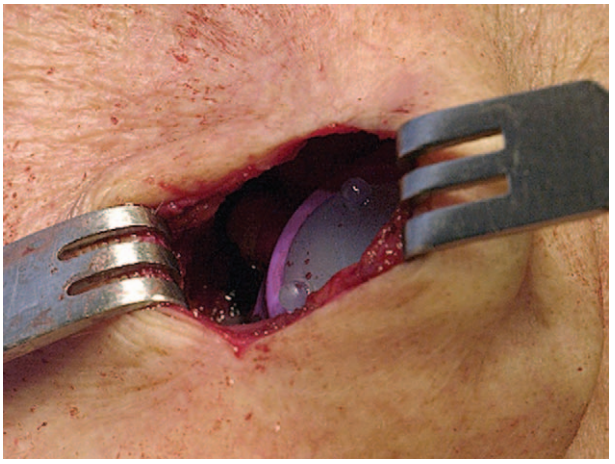

Figure 5. Reservoir implantation.

4. Discussion

This study revealed that the cephalic vein approach can be safely performed and has acceptable surgical, clinical, and functional outcomes compared to conventional percutaneous techniques. Central venous access devices in cancer patients were first introduced in 1982[7] to reduce complications associated with frequent venous puncture during chemotherapy. There are several approaches for implantable central venous access. While the IJV approach with real-time USG has been widely performed because it has a good success rate without increasing the procedure duration,[8,9] we noticed that the surgical and clinical outcomes of the existing central venous approaches seem to be comparable.[10–12] Despite its safety and feasibility, the conventional IJV approach requires specialized and expensive medical resources, including percutaneous vascular surgical kits, tunneling instruments, vascular USG, and/or fluoroscopic techniques; therefore, this approach might preclude wide clinical applications in small-volume regional hospitals or private clinics. Comparatively, the subclavian vein approach using the Seldinger landmark technique without a USG can be considered alternatively because it is easily performed with no special equipment; however, this approach might cause life-threatening complications such as hemothorax, pneumothorax, mediastinal hematoma, vascular perforation, and myocardial injury.[13] Consequently, we employed the cephalic vein cut-down approach to reduce the risk of immediate complications[14] while achieving cost-effectiveness and patient comfort. Several studies have reported that the cephalic vein approach can avoid possible immediate fatal complications, including pneumothorax and arterial puncture, although this approach might have a low success rate.[15–19]

In our study, the general surgeons performed central venous catheter insertion, and the failure rate of cephalic vein access was found to be 12.5%, which was superior to that of previous reports, ranging from 12% to 20%.[11,17–21] This result is similar to that of IJV and subclavian access.[9,19] Of the 136 patients who received the cephalic vein approach, the diameter of the cephalic vein was recorded in 62 cases. The mean diameters were 3.1 mm in the success group and 2.2 mm in the failure group, which were statistically significant ($P < .01$); therefore, we carefully suggest that identifying the diameter of the cephalic vein would be helpful in successful procedure attempts. Two cases of immediate complications were found in the cephalic vein group (1.7%), and late complications occurred in 7 cephalic vein cases (5.9%). These results were similar to those of cephalic vein access in previous studies.[16–23] Additionally, the complication rate of cephalic vein access in this study was lower than that of IJV access and subclavian access in other studies.[9,18,19] Accordingly, we suggest that the cephalic vein cut-down approach can be safely performed with a comparable success rate and without increasing acute and late catheter-related complications compared to those of conventional percutaneous approaches. In addition, previous studies have shown that age, underlying cancer type, prior anticoagulant therapy, catheter tip position, and surgeon are independent prognostic factors for catheter complications.[9,24–26] However, in our study, patient BMI, age, and operation time

Table 1

Demographic characteristics and clinical outcomes according to the venous access.

	Total (N = 508)	Subclavian (N = 230)	Int.jugular (N = 134)	Ext.jugular (N = 25)	Cephalic (N = 119)	*P*-value*	*P*-value†	*P*-value‡
Gender (male/female)	176/332	77/153	40/94	8/17	51/68	.08	.03	.32
Age, yr	56.81 ± 11.42	55.72 ± 11.20	57.20 ± 11.76	58.36 ± 13.52	58.14 ± 10.92	.04	.56	.58
Cancer type (N)						<.01	<.01	.17
Colorectal	201 (39.57%)	81 (35.22%)	46 (34.33%)	10 (40.00%)	64 (53.78%)			
Breast	235 (46.26%)	112 (48.70%)	71 (52.99%)	10 (40.00%)	42 (35.29%)			
Stomach and esophagus	47 (9.25%)	26 (11.30%)	15 (11.19%)	1 (4.00%)	5 (4.20%)			
Lung	8 (1.57%)	3 (1.30%)	1 (0.75%)	0 (0.00)	4 (3.36%)			
Gyncecology	6 (1.18%)	2 (0.87%)	0 (0.00)	2 (8.00%)	2 (1.68%)			
Hematologic	6 (1.18%)	4 (1.74%)	0 (0.00)	1 (4.00%)	1 (0.84%)			
Hepatobiliary	1 (0.20%)	1 (0.43%)	0 (0.00)	0 (0.00)	0 (0.00)			
Others	4 (0.79%)	1 (0.43%)	1 (0.75%)	1 (4.00%)	1 (0.84%)			
BMI, kg/m^2	23.84 ± 3.51	23.59 ± 3.26	24.35 ± 3.94	22.85 ± 4.01	23.95 ± 3.32	.53	.34	.09
Side of venous access (Rt /Lt)	371/136	158/72	102/31	16/9	96/23	.02	.38	.07
Operation time, min	46.92 ± 21.90	38.14 ± 16.02	53.74 ± 26.85	69.16 ± 22.38	51.55 ± 17.86	<.01	.59	<.01
Length of use, mo	7.93 ± 7.62	8.14 ± 8.15	7.92 ± 7.61	8.21 ± 9.05	7.46 ± 6.20	.7	.73	.68
Chemotherapy cycles (N)	9.7 ± 8.01	9.88 ± 7.92	9.34 ± 7.23	10.52 ± 17.76	9.57 ± 5.55	.51	.28	.11
Immediate complications (N)	6 (1.18%)	4 (1.74%)	0 (0.00)	0 (0.00)	2 (1.68%)	N/A	N/A	N/A
Cause of removal (N)						.73	.13	.43
End of the treatment	406 (79.92%)	181 (78.70%)	109 (81.34%)	19 (76.00%)	97 (81.51%)			
Infection	11 (2.17%)	5 (2.17%)	4 (2.99%)	1 (4.00%)	1 (0.84%)			
Malfunction	18 (3.54%)	9 (3.91%)	1 (0.75%)	2 (8.00%)	6 (5.04%)			
Decease of the patients	73 (14.37%)	35 (15.22%)	20 (14.93%)	3 (12.00%)	15 (12.61%)			

Values are numbers (percentages) for categorical variables and as mean ± standard deviation for continuous variables.

P-values were calculated using Chi-square test or Fisher exact test for categorical variables and independent *t* test for continuous variables.

* Comparison between subclavian vein and cephalic vein.

† Comparison between internal jugular vein and cephalic vein.

‡ Comparison between external jugular vein and cephalic vein.

did not increase the risk of long-term catheter dysfunction in univariate and multivariate logistic regression analyses; therefore, it seems reasonable that a central venous port can be considered in elderly or obese patients.

Since our procedures were performed by several surgeons, there might have been interoperator variations as well as other confounding biases associated with the retrospective study design. Moreover, there might have been a reporting bias in analyzing the cephalic vein diameter between success and failure groups because the small size of the cephalic vein tended to be emphasized when the procedure failed. Nevertheless, our study was performed with a sufficiently large sample size, and the surgical records were documented by the specialized medical recorder immediately after the surgery. All surgeries were performed according to identical protocols. We suggest that these features might enhance the level of evidence of our study.

Table 2

Multivariate risk factors analysis for the late complications.

	OR (95% CI)	*P*-value
Venous access		.9
Cephalic vein approach	1.000	
Other approaches*	0.946 (0.391, 2.291)	
BMI	1.033 (0.933, 1.144)	.53
Operation time	1.004 (0.988, 1.020)	.66
Age	0.978 (0.947, 1.011)	.19

P-value was calculated using multivariate logistic regression analysis after the correction of confounder effects.

BMI = body mass index, CI = confidence interval, OR = odds ratio.

* Included subclavian, internal jugular, and external jugular approaches.

5. Conclusions

The present study demonstrates that cut-down central venous catheter insertion through the cephalic vein can be performed safely by nonvascular surgeons with no differences in surgical and clinical outcomes compared to those of conventional percutaneous approaches. Moreover, this approach requires no specialized equipment, including percutaneous vascular kits, tunneling instruments, and intraoperative USG. Therefore, the cephalic vein cut-down technique might incur less medical expenses than conventional approaches and would be helpful for both patients and surgeons.

Author contributions

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Writing – original draft: Jiyoung Rhu.
Writing – review and editing: Jinbeom Cho.
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