ORIGINAL ARTICLE

Outcome analysis in 270 radiologically guided implantations of totally implantable venous access ports via basilic vein

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Abstract

Background: Totally implantable venous access ports (TIVAPs) are widely applied in patients who require chemotherapy, parenteral nutrition, or frequent intravenous drug infusion. Although various venous access routes are possible for TIVAP insertion, the best method remains a topic of controversy. We present a single-center retrospective study of radiologically guided placement of TIVAPs through the basilic vein, with analysis of technical feasibility, patient safety, and device-related complications.

Methods: We retrospectively reviewed 270 patients who received TIVAP implantation through the basilic vein from November 2013 to July 2016, under imaging guidance by an interventional radiology team at our institution. Fluoroscopic images, chest radiographs, computed tomography scans, and medical records were reviewed after port implantation. Catheter maintenance days were calculated and catheter-related complications were recorded.

Results: The procedural success rate was 99.3%. In total, 270 TIVAPs were implanted in 270 patients, of which 150 remained functional at the end of the study period. The total catheter maintenance days was 77 543 days, and the mean catheter indwelling duration was 287 ± 207 days. In 20 (7.4%) patients, TIVAP-related complications occurred during the follow-up period, resulting in a postprocedural complication rate of 0.26 incidences per 1000 catheter days. No significant relationship was observed between complications and gender ($p = 0.188$), age ($p = 0.528$), body mass index ($p = 0.547$), the type of primary malignancy ($p = 0.914$), or between the left and right basilic veins ($p = 0.319$).

Conclusion: Real-time ultrasound and fluoroscopic guidance provides a safe method for TIVAP implantation through the basilic vein, with a high technical success rate and few device-related complications.

Keywords: Central venous access; Complication; Interventional radiology; Port catheter

1. INTRODUCTION

Since the first report by Niederhuber et al.[1] in 1982, totally implantable venous access port (TIVAP) has been widely used in patients who require chemotherapy, parenteral nutrition, or frequent intravenous medication. Along with the rise in the number of patients with cancer worldwide, the need for TIVAPs has also seen a consistent increase.[2] Studies have revealed that radiologically guided TIVAP implantation is a safe and cost effective procedure.[3–8] More recently, investigators have demonstrated a higher rate of technical success and lower rate of complication for radiologic port placement under ultrasound guidance, compared with surgical cut-down and landmark-based implantation.[9–12] Various venous access routes have been used by authors for TIVAP insertion. Shiono et al.[2] reported the considerable benefits of establishing TIVAP access through the upper arm, including a significantly lower overall postprocedural complication rate, prevention of pinch-off syndrome, increased patient comfort, and better postprocedure cosmetic appearance. However, studies focusing on the outcomes of TIVAPs inserted specifically through the basilic vein remain rare in the literature. Therefore, we present a single-center retrospective study of the radiologic placement of TIVAPs through the basilic vein, with safety, technical feasibility, and device-related complications set as the primary outcomes.

2. METHODS

2.1. Patients

This single-center study was approved by the institutional review board of our hospital. We retrospectively included patients who received TIVAP implantation under imaging guidance by an interventional radiology team at our institute, from November 2013 to July 2016. All patients received TIVAP placement for the administration of chemotherapy. The patients' baseline characteristics are summarized in Table 1, and the primary malignancy for each patient is presented in Table 2. Port systems were selected according to the patient's arm size, with low-profile ports (POLYSITE with adult microport, Perouse Medical,

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Table 1

Patients' characteristics

Patients' characteristics	
Gender	n (%)
Male	151 (55.9)
Female	119 (44.1)
Age (y)	59.7 ± 11.1
Body mass index (kg/m^2)	23.8 ± 4
Left or right basilica vein of TIVAP insertion	n (%)
Left	237 (87.8)
Right	33 (12.2)

TIVAP = totally implantable venous access port.

Table 2

Primary malignancies of patients

Primary malignancy	n (%)
Lung cancer	218 (79.9)
Hematological malignancy	19 (7)
Head and neck cancer	17 (6)
Breast cancer	3 (1)
Cholangiocarcinoma	3 (1)
Colorectal cancer	3 (1)
Gastric cancer	2 (0.7)
Esophageal cancer	1 (0.4)
Pancreatic cancer	1 (0.4)
Urothelial carcinoma	1 (0.4)
Ovarian cancer	1 (0.4)
Osteogenic sarcoma	1 (0.4)
Other solid tumors	3 (1)[a]
Total	273[b]

[a]Including a retroperitoneal leiomyosarcoma, an axillary angiosarcoma, and a metastatic lymphoepithelial-like carcinoma with unknown primary origin.
[b]Three patients had two synchronous carcinomas.

Ivry-le-Temple, France) being used in most cases because of the relatively slim arms of Asian patients. The basilic vein of a patient's nondominant arm was used whenever possible. In patients with pacemakers, a history of axillary lymph node dissection or subclavian venous catheter placement, the ports were placed in the contralateral arm. Exclusion criteria were active systemic infection, local infection at the port implantation site, uncorrectable coagulopathy, and venous thrombosis or stenosis over the access route.

2.2. Port placement

Before port implantation, the most recent thoracic images for each patient (if available) were reviewed to confirm patency of the access route. Informed consent was obtained from all patients before the procedure. The procedure was performed under sterile conditions in an interventional radiology angiography suite, by a team consisting of an interventional radiologist, a resident of the radiology department, a radiographer, and a registered nurse. No routine prophylactic antibiotic or anticoagulant was administered. The patient was positioned with the arm abducted and externally rotated. Ultrasound examination of the basilic vein was performed to determine the patency and the size of the vein. The puncture site of the basilic vein was marked approximately 3–5 cm proximal to the elbow. The skin was prepared with chlorhexidine. The basilic vein was punctured under real-time ultrasound guidance using an 18-G needle. After successful puncture, a 0.035-inch guidewire was inserted along the needle into the superior vena cava (SVC) under fluoroscopic guidance. Venography was not routinely performed unless the guidewire could not be smoothly introduced into the SVC. A port reservoir pocket was created approximately 2–3 cm lateral to the puncture site under adequate local anesthesia (lidocaine 2%), and electrocauterization was used to achieve hemostasis. A peel-away dilator sheath was introduced along the guidewire, after which the guidewire was withdrawn. A port catheter was immediately inserted into the sheath, and the catheter tip was positioned at the cavoatrial junction under fluoroscopic guidance (Fig. 1A). The sheath was then peeled away during its withdrawal from the vessel. A subcutaneous tunnel from the port reservoir pocket to the puncture site was created using a tunneling device, to which the catheter was attached and pulled through the tunnel. Excess catheter length was trimmed, and the remaining length was attached to the injection port. The port was then placed into the reservoir pocket (Figure 1B), with anchoring suture being used as necessary. The port system was flushed with 10 mL of heparinized normal saline (50 IU/mL), and the wound was closed in two layers. Finally, fluoroscopic images in the supine position with the patient's arm abducted and adducted were obtained to document the position of the catheter tip and port.

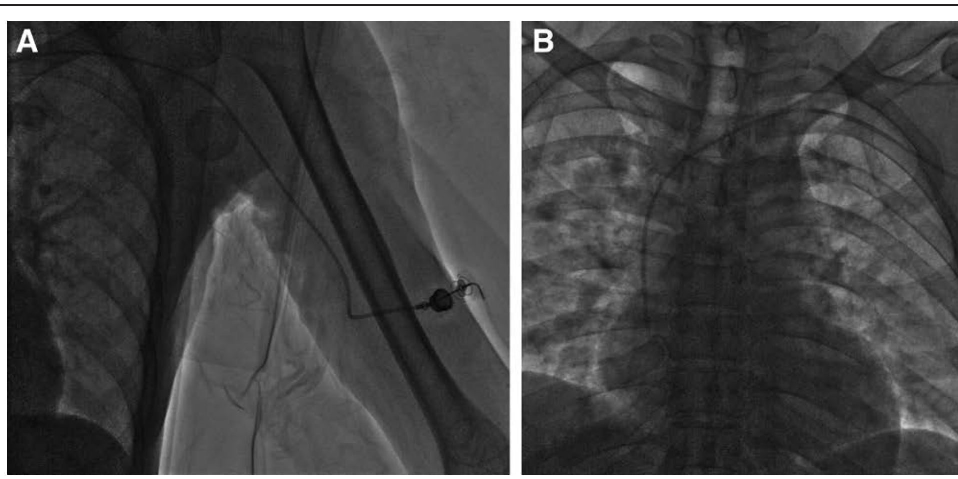

Fig. 1 Rdiograph of the TIVAP implant. A, The port was implanted lateral to the puncture site and near the midline of the upper arm when the patient was in a neural position. B, The catheter tip was placed at the cavoatrial junction under fluoroscopic guidance. The level was approximately two vertebral bodies below the carina. TIVAP = totally implantable venous access port.

2.3. Follow-up and catheter maintenance

We retrospectively reviewed the fluoroscopic images, chest radiographs, computed tomography (CT) scans, and medical records whenever each patient returned to the outpatient department, emergency department, or was admitted for hospital stay. Patients were removed from the study if they were lost to follow-up, expired, or had their TIVAP removed. The follow-up flow chart is presented in Figure 2. Catheter maintenance days were calculated as the number of days between port implantation and the date of one of the following: last visit to our hospital, patient death, or TIVAP removal. Complications were defined as early and late complications according to the Society of Interventional Radiology technology guidelines.[13] Catheter-related venous thrombosis was identified through CT venography if there were filling defects along the TIVAP catheter, and associated infections were classified into local and bloodstream types. Catheter occlusion was defined as medical record stated an inability to inject when flushing or fluid injection from TIVAP. Local infections were defined as local redness and swelling with pus formation at the TIVAP implantation site. Whenever a patient exhibited systemic inflammatory response syndrome and positive blood culture without an identifiable infection source, a catheter-related blood stream infection was considered.

2.4. Statistical analysis

Binominal logistic regression analysis was performed to evaluate the relationship between post-procedural complications and age, body mass index (BMI), procedure time, and TIVAP insertion site (in left or right arm). A chi-squared test was used for comparisons in terms of complications, gender, and type of primary malignancy (solid or hematogenous). All data were analyzed using SPSS (version 22.0, SPSS, Chicago, IL). Two-sided p values of <0.05 were considered significant.

3. RESULTS

TIVAP implantation through the basilic vein failed in two patients because of stenosis in the proximal basilic vein and the physical difficulty of venous access. The technical success rate was 99.3%. In total, 270 TIVAPs were implanted in 270 patients (119 women and 151 men), with a mean age of 59.7 ± 11.1 years (range 23–89 years). The BMI of patients' was 23.8 ± 4 kg/m^2 (range 15.7–43.8 kg/m^2). A total of 150 ports were still functional at the time of data collection. The remaining 120 ports did not reach the time of data collection because of patients being lost to follow-up (n = 27), patient death (n = 72), or the removal of TIVAPs (n = 21) (Figure 2). In the 72 patients who died, 67 conserved a normal port function according to their medical records. In the 21 patients who underwent port removal, four had ports removed because of completion of therapy course rather than because of port-related complications. The total number of catheter maintenance days was 77 543, and the mean catheter indwelling duration was 287 ± 207 days (range 1–905 days). In terms of location, 237 devices (87.8%) were implanted through the left basilic vein, and 33 devices (12.2%) were implanted through the right basilic vein.

In 20 (7.4%) patients, TIVAP-related complications occurred during the follow-up period, resulting in a postprocedural complication rate of 0.26 incidents per 1000 catheter days (Table 3). Five (1.9%) were early complications, and 15 (5.6%) were late complications. Catheter-related central venous thrombosis was observed in five (1.9%) patients. In two (0.7%) patients, injection from the port was difficult without evidence of catheter tip migration or kinging. Catheter-related infections were noted in eight (3%) patients, with two (0.7%) having local infections and six (2.2%) having blood stream infections. One of the patients was diagnosed as having a blood stream infection after parental nutrition from the port subsequent to chemotherapy. Skin dehiscence at the port implantation site occurred in two (0.7%) patients. Port rotations (Fig. 3) were observed in two

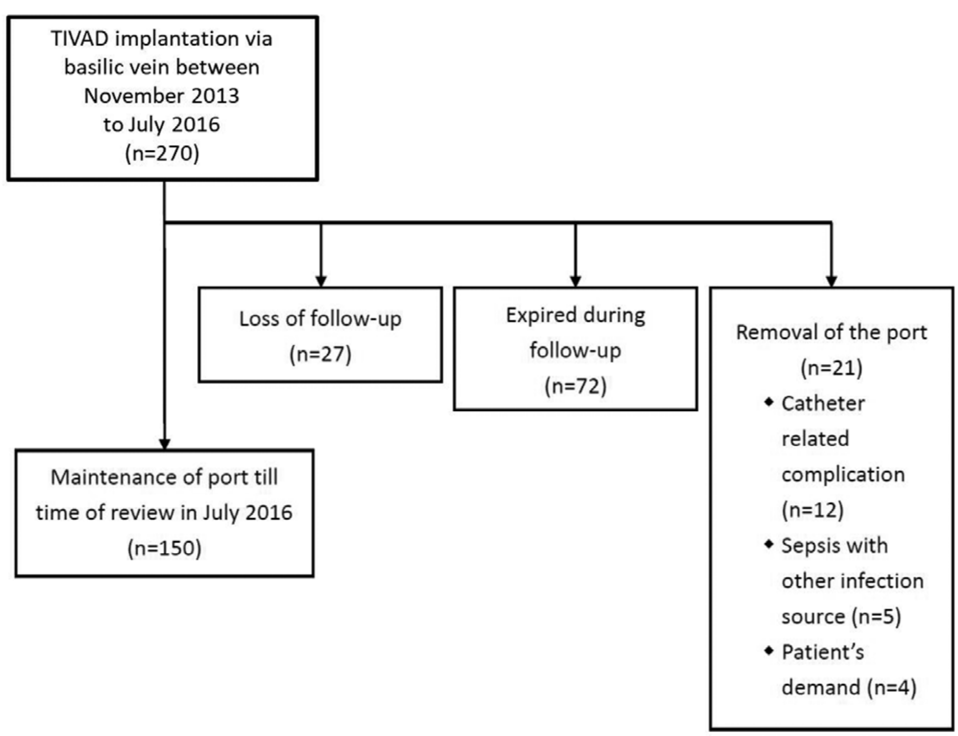

Fig. 2 Follow-up flow chart. TIVAD.

Table 3

Early and late TIVAPs-related complications

	Early complication (≦30 d)				Late complication (>30 d)				Total			
	n	%	/1000 d	Explanation	n	%	/1000 d	Explanation	n	%	/1000 d	Explanation
Infection	2	0.7	0.03	1	6	2.2	0.08	6	8	3	0.10	7
Local	0	0	0	0	2	0.7	0.03	2	2	0.7	0.03	2
Blood stream	2	0.7	0.03	1	4	1.5	0.05	4	6	2.2	0.08	5
Venous thrombosis	2	0.7	0.03	2	3	1.1	0.04	0	5	1.9	0.06	2
Catheter occlusion	0	0	0	0	2	0.7	0.03	0	2	0.7	0.03	0
Port rotation	1	0.4	0.01	1	1	0.4	0.01	0	2	0.7	0.03	1
Leakage	0	0	0	0	1	0.4	0.01	1	1	0.4	0.01	1
Skin dehiscence	0	0	0	0	2	0.7	0.03	1	2	0.7	0.03	1
Total	5	1.9	0.06	4	15	5.6	0.19	8	20	7.4	0.26	12

TIVAP = totally implantable venous access port.

(0.7%) patients. Leakage from the port and catheter connection occurred in one (0.4%) patient (Fig. 4). In total, 12 (4.4%) ports were removed due to complications.

A Kaplan–Meier survival curve was created for the 270 ports, ports inserted from the right basilic vein, and ports inserted from the left basilic vein are illustrated on Figure 5. The TIVAPs inserted through the right basilic vein exhibited a higher Kaplan–Meier survival curve than the TIVAPs inserted through the left basilic vein, but no significant difference was noted between them (p = 0.319). In addition, no significant relationship was observed between complications and gender (p = 0.188), age (p = 0.528), BMI (p = 0.547), or the type of primary malignancy (p = 0.914).

4. DISCUSSION

The implantation of TIVAP by radiologists using the Seldinger technique under real-time ultrasound and fluoroscopy guidance has been used worldwide in patients requiring chemotherapy, total parenteral nutrition, or frequent intravenous medication. In our study, an excellent technical success rate (99.3%) was obtained for TIVAPs inserted through the basilic vein, with low complication rates. Several factors that might have influenced the procedure outcomes were collected for each patient, including age, gender, BMI, type of primary malignancy, and port insertion site. However, no statistically significant relationship was noted between these factors and postprocedural complications.

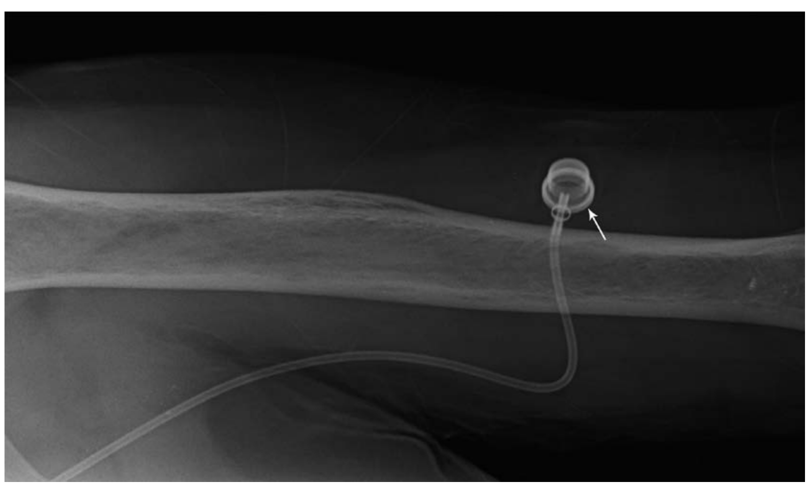

Fig. 3 Patient with a port rotated by 180°, with the injection membrane (arrow) turned toward the humeral bone.

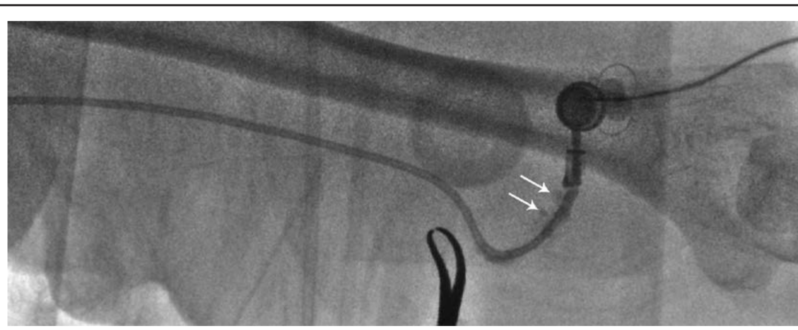

Fig. 4 Patient with fluoroscopy-proven leakage (arrow) at the junction between the catheter and the port.

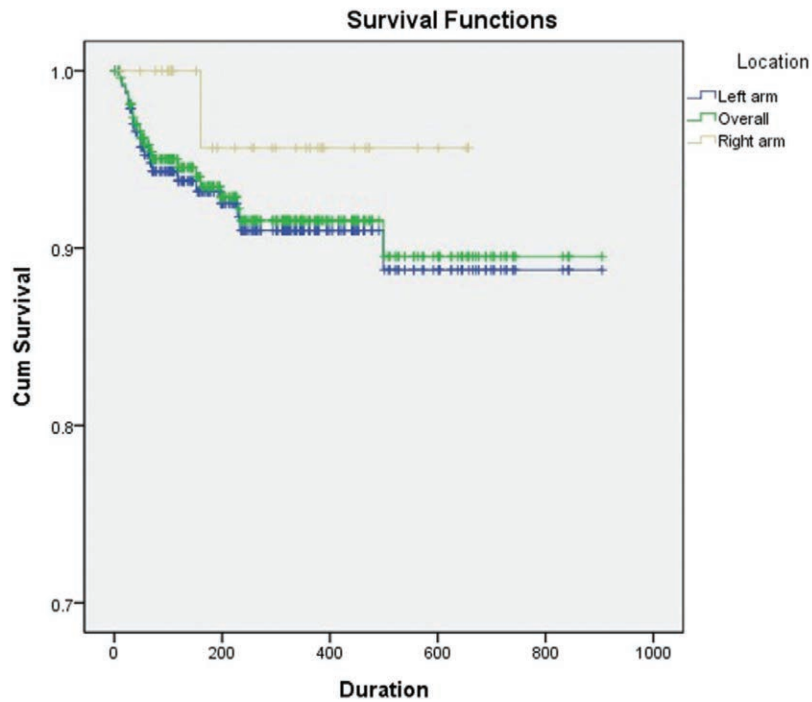

Fig. 5 Catheter Kaplan–Meier survival curve.

The Seldinger technique has a higher primary success rate than conventional surgical venous cut-down techniques.[9] However, a higher complication rate has been reported when the subclavian vein (SCV) is used for vascular access, as opposed to surgical venous cut-down through the cephalic vein.[9,10] Real-time image guidance may improve the technical success rate of this technique and lower the procedure-related complication rate compared with conventional surgical methods.[11]

Several access routes, including the cephalic vein, internal jugular vein (IJV), SCV, axillary vein, basilica vein, brachial vein, and cubital vein, have been used. Though the cephalic vein is more superficial, it has been recognized that venous access through that vein results in higher complication rates than through the brachial route.[8,14] Alternatively, IJV access is considered to be superior to SCV access in terms of technical success rate, complication rate, and procedure time.[15–17] Catheter insertion through the IJV can also decrease the possibility of arterial puncture or pneumothorax, as well as avoid the potential technical difficulties due to the acute angle of the SCV as it joins the IJV to form the brachiocephalic vein.[18] However, brachial plexopathies can occur after IJV or SCV catheterization,[18] and port implantation through IJV may cause Horner syndrome even under ultrasound guidance.[19] Shiono et al.[2] demonstrated that TIVAPs implanted through the upper arm have a significantly lower overall postprocedural complication rate compared with the subclavian vein, all without the risk of pneumothorax or pinch-off syndrome. A recent retrospective study also revealed that TIVAP implantation through an upper-arm vein has lower complication rates than either the IJV or SCV location, and remains more convenient and comfortable for patients.[20] Another study reported that when performing certain daily activities, more subjective discomfort was observed in patients with TIVAPs situated in the chest compared with those in the forearm.[21] Other potential advantages of upper-arm implantation have been described, including the fact that patients may experience less fear than for a subclavian or internal jugular puncture as well as improved cosmetic appearance.[2]

Although concerns have been raised regarding the fact that forearm TIVAPs may be more prone to mechanical stress considering that catheters must cross the elbow joint,[22] no significant difference in the rates of infection, venous thrombosis, catheter migration, or occlusion has been observed to date between the upper-arm and forearm ports.[23] However, upper-arm ports may still provide a better quality of life than forearm ports, because the injection sites of upper-arm ports can more easily be covered by a short-sleeve shirt.[23] Other benefits of TIVAP insertion through the basilic vein have been reported, including the convenience of compression by hand for hemostasis, and the absence of major arteries nearby.[2]

Kaplan–Meier survival curves indicated that TIVAPs inserted from the right side had slightly better outcomes than those inserted from the left side in our study, although no statistically significant differences observed. A study by Ignatov et al.[24] also demonstrated that TIVAPs placed on the left chest had a higher incidence of complications. This might be caused by the relatively steep angle of the left brachiocephalic vein as it enters the SVC compared with the right side, which may cause injury when the catheter tip is being pushed inferiorly during implantation. Further injury of the endothelium induced by chronic microtrauma and local toxicity of the subsequent chemotherapy might predispose the vein to thrombosis and infection.[24]

The correct positioning of the port catheter tip at the cavoatrial junction has been regarded as a key factor in preventing thrombosis.[8,25] Longer intravascular catheter length has previously been suggested as a risk factor in the development of venous thrombosis by some authors.[22,26] However, other studies have reported that despite having significantly longer intravascular catheters, TIVAPs inserted in the arm may not be any more prone to thrombosis than chest ports.[23,27] Our data supported this finding; a low venous thrombosis rate was observed in TIVAPs inserted through the basilic vein. We therefore posit that catheter length is probably not a major risk factor in the development of venous thrombosis after port implantation.

Table 4

Comparison with the results of recent studies' as performed by interventional radiologists

Author	Access vein	TIVAP No. follow-up period (mo)	Technical success rate (%)	Total catheter maintenance (d) Mean	Total complication rate (%) (/1000 d)	Infection rate (%) (/1000 d)	Thrombosis rate (%) (/1000 d)	Prophylactic antibiotics use
Teichgräber et al.[28]	IJV	3160 104	99.8	922 599 292	12.7 0.36	5.7 0.16	3.7 0.11	No
Ahn et al.[15]	IJV	1254 87	99.9	433 386 350	5 0.13	0.6 0.02	0.5 0.01	Yes*
Zhou et al.[29]	IJV and SCV	492 48	100	176 649 359	13.2 0.37	1.8 0.05	2.4 0.07	No
Seo et al.[33]	Axillary vein	216 5	100	N/A 165.7	1.4 N/A	0 N/A	0.5 N/A	N/A
Busch et al.[7]	Brachial vein	523 66	99.0	127 750 248	9.8 0.39	5.3 0.21	1.6 0.06	No
Shiono et al.[2]	Basilic and brachial vein	257 72	98.8	N/A N/A	4.7 N/A	3.1 N/A	1.2 N/A	Yes
Wildgruber et al.[8]	Cubital vein	1704 2004–2012	99.2	643 200 380.6	14.4 0.38	3.6 0.10	4.2 0.11	Yes*
Present study	Basilic vein	270 32	99.3	77 543 287	7.4 0.26	3.0 0.10	1.9 0.06	No

IJV = internal jugular vein, N/A = not available, SCV = subclavian vein.
[a]Only in high-risk patients.

Ignatov et al.[24] reported that patients with a BMI of >28.75 kg/m[2] are more prone to complications after chest port insertion. Nevertheless, no significant relationship was noted between BMI and complication in our data. We inserted all TIVAPs using the Seldinger technique under real-time ultrasound and fluoroscopy guidance; this technique may decrease the complication rate in patients with a high BMI.

Compared with recent studies of TIVAPs performed by radiologists using the Seldinger technique (Table 4), the outcomes of TIVAPs inserted through the basilic vein in this study have a similar technical success rate and complication rate. Because of the difference in the number of patients and the length of the follow-up period among studies, comparing complications per 1000 catheter indwelling days is more representative than a raw percentage. Although the definition of various complications tends to vary in the literature, there appears to be a tendency toward a negative correlation between complication rate and mean catheter indwelling days. The complication rate per 1000 catheter indwelling days between IJV port studies seems to vary,[15,28,29] with the operator experience being a major factor in the success of port insertion through IJV and in reducing subsequent complications. Compared with other studies on TIVAPs implanted in the upper arm or forearm, our study had a favorable outcome in terms of complication per 1000 catheter indwelling days.

In our study, the infection rate was comparable to that in studies where prophylactic periprocedural antibiotics were used (Table 3). This is supported by a recent meta-analysis study that demonstrated that routine prophylactic antibiotics administration had no significant benefits in lowering the port infection rate.[30] However, higher infection rates in patients with hematogenous malignancy rather than solid malignancies have been reported by Samaras et al.[31] and Hsieh et al.[32] Whether or not prophylactic antibiotics are beneficial in selected high-risk patients is a concern requiring further clarification.

The first limitation of our study is its retrospective nature. Patients were referred for arm port placement according to clinicians' preference rather than being randomly allocated. Moreover, given that most of the patients in our study had lung cancer as their primary malignancy, with only a few cases of hematogenous neoplasm, selection bias may have influenced the complication rate. Although some reports have suggested a higher risk of port infections in hematogenous malignancies rather than solid malignancies,[31,32] we did not address this problem in the current study. Further investigation is warranted to clarify the relationship between the type of primary tumor and post-TIVAP complications. In this study, only one interventional radiologist was involved and operator's experience may be considered a factor that affects procedure results. In our opinion, for an interventional radiologist who is familiar with the placement of a peripherally inserted central venous catheter, arm port placement would be a similar procedure after they have received add-on training for subcutaneous port placement. Finally, we collected data mainly by reviewing patients' medical records, and minor complications not stated in the records may have been overlooked.

In conclusion, our study reveals that TIVAP implantation through the basilic vein, with port placed in the upper arm under real-time ultrasound and fluoroscopic guidance is a safe procedure with a high technical success rate and low complication rate.

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Author Contributions: Dr. Chia-Yu Kao and Dr. Chien-Hua Fu contributed equally to this study.

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