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A Prospective Analysis of the Cephalic Vein Cutdown Approach for Chronic Indwelling Central Venous Access in 100 Consecutive Cancer Patients

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Background: Chronic indwelling central venous access devices (CICVAD) generally are placed by the percutaneous subclavian vein approach. The cephalic vein cutdown approach is used only infrequently. Although the technique has been well described, few prospective data are available on the cephalic vein cutdown approach.

Methods: From September 9, 1998, to July 20, 1999, the cephalic vein cutdown approach was attempted in 100 consecutive cancer patients taken to the operating room with the intention of placing CICVAD. Median patient age was 54.5 years (range 18–88), with 46 men and 54 women. Twenty-five patients had gastrointestinal malignancies, 17 had breast cancer, 15 had lymphoma, 13 had lung cancer, 12 had leukemia, 5 had multiple myeloma, and 13 had other malignancies. Patients were followed prospectively for immediate and long-term outcome.

Results: CICVAD placement via the cephalic vein cutdown approach was successful in 82 patients; the remaining 18 patients required conversion to a percutaneous subclavian vein approach. The reasons for inability to place CICVAD via cephalic vein cutdown approach were a cephalic vein that was too small (10 patients), an absent cephalic vein (7 patients), and inability to traverse the angle of insertion of the cephalic vein into the subclavian vein (1 patient). There were 56 subcutaneous ports and 26 tunneled catheters. Median operating time was 44 minutes (range, 26–79 minutes). No postoperative pneumothorax occurred. Median catheter duration was 198 days (range, 0–513 days). Long-term complications included catheter-related bacteremia (6%), site infection (2%), deep venous thrombosis (5%), port pocket hematoma (1%), and superior vena cava stricture (1%). Thirty-seven percent of patients have died since CICVAD placement. Twenty-nine percent of the CICVADs have been removed.

Conclusions: The cephalic vein cutdown approach was successful in 82% of patients. This approach is a safe and useful alternative to the percutaneous subclavian vein approach.

Key Words: Cephalic vein—Subclavian vein—Central venous access—Implanted port—Tunneled catheter—Complications.

Chronic indwelling central venous access devices (CICVAD), whether tunneled catheters or implanted ports, generally are placed by the percutaneous subclavian vein approach. In contrast, the cephalic vein cutdown approach is used infrequently in clinical practice for the placement of CICVADs. A review of the literature suggests that the cephalic vein cutdown approach has been relatively well described,[1–19] but few prospective data on its use are available. The objective of the present study was to prospectively evaluate the immediate and long-term outcome of the cephalic vein cutdown approach for CICVAD placement in 100 consecutive cancer patients.

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PATIENTS AND METHODS

Patients

Between September 9, 1998, and July 20, 1999, 100 consecutive cancer patients, taken to the operating room

with the intention of placing a chronic indwelling central venous access device (CICVAD), were subjected to an attempted cephalic vein cutdown approach for CICVAD placement. All patients were followed prospectively through February 21, 2000, giving a maximum duration of prospective follow-up of 530 days. Prospective follow-up outcome variables included immediate postoperative complications (e.g., pneumothorax, hemothorax, and injury to the great vessels) and long-term complications, including infectious and noninfectious complications. Infectious complications included catheter-related bacteremia and site infections. Site infection was defined as either subcutaneous catheter tunnel infections or subcutaneous port pocket infections. Noninfectious complications included deep venous thrombosis, subcutaneous port pocket hematoma, and great vessel stricture/stenosis. The end point for prospective follow-up was defined as the time of catheter removal or the time of patient death (if the catheter was still in place). Median catheter duration was defined as the length of time between catheter placement and catheter removal or the length of time between catheter placement and the death of the patient (if the catheter was still in place).

Method of Catheter Insertion

A single surgeon (SPP) inserted all the CICVADs. Two types of CICVAD were used: BardPort® titanium implanted single lumen (9.6-French or 6.6-French) ports (Bard Access Systems, Salt Lake City, UT) or Leonard® (10-French)/Hickman® (12-French) dual-lumen tunneled central venous catheters (Bard Access Systems).

Each patient was brought to the operating room and placed on the operating room table in a supine position. A rolled sheet was placed vertically in the small of the patient's back to rotate his or her shoulders posteriorly. Trendelenburg positioning was not necessary for the cephalic vein cutdown approach. The procedure generally was performed under monitored intravenous sedation, using local anesthetic. However, if the patient required general anesthesia for other concurrent surgical procedures or requested general anesthesia, the procedure was performed under general anesthesia. The patient's entire chest and neck were prepped and draped in a sterile fashion. A 4-cm incision was made in the infraclavicular location along the course of the deltopectoral groove. The subcutaneous tissues were dissected down to the fascia overlying the junction of the deltoid muscle and the pectoralis major muscle, thus identifying the deltopectoral groove. The cephalic vein was located within the adipose tissue of the deltopectoral groove and circumferentially dissected out for approximately 2 to 3 cm. Two separate 2–0 silk sutures were then placed around the cephalic vein, one proximally and one distally around the cephalic vein. The 2-0 silk suture placed distally around the cephalic vein was tied down securely. The cephalic vein was then partially transected with a No. 11 blade in a transverse fashion along its midportion. Back-bleeding from the proximal end of the cephalic vein was controlled by applying traction to the proximally placed 2–0 silk suture. The catheter was then passed proximally into the lumen of the partially transected cephalic vein with the assistance of a vein pick and advanced centrally into the subclavian vein, the innominate vein, and the superior vena cava. Using real-time fluoroscopic guidance, the tip of the catheter was positioned in the superior vena cava, usually at the junction of the superior vena cava and right atrium. Once the catheter was correctly positioned, the proximally placed 2–0 silk suture around the catheter and the proximal end of the cephalic vein was tied down in a nonconstricting fashion to prevent back-bleeding and catheter migration. For implanted ports, the catheter was connected to the port, and the port was positioned and secured in a port pocket created along the inferior aspect of the infraclavicular incision using nonabsorbable suture. For tunneled catheters, the catheter was tunneled along the ipsilateral chest wall with its exit site from the skin located on the medial aspect of the ipsilateral chest wall at the level of the ipsilateral nipple before passing the tunneled catheter into the cephalic vein. The subcutaneous tissues and skin of the infraclavicular incision were then closed in separate layers using absorbable suture. The function of the catheter lumen was tested by attempting to aspirate blood and by flushing the lumen with dilute heparinized saline solution (10 units of heparin per ml of saline). The lumen of the catheter was then filled with the appropriate amount of more concentrated heparinized saline solution (100 units of heparin per ml of saline). If the CICVAD could not be placed by the cephalic vein cutdown approach, it was placed by the standard percutaneous subclavian vein approach with the patient in Trendelenburg position.

Statistical Analyses

The software program SPSS© for Windows (version 8.0) from SPSS, Incorporated (Chicago, Illinois) was used for all statistical analyses. One-way analysis of variance (ANOVA) was used to compare the means of continuous variables. Pearson χ^2 analysis with Yates' correction for continuity or Fisher's exact test, when appropriate, was used for univariate comparisons for all categorical variables. Differences in catheter-related bacteremia per 1000 catheter days, site infections per 1000 catheter days, and overall catheter-related infection per

1000 catheter days were examined by Kaplan-Meier analysis using the log-rank test. A *P* value of less than or equal to .05 was considered statistically significant. No direct comparison of the results of those patients undergoing the cephalic vein cutdown approach to those of the patients undergoing the percutaneous subclavian vein approach was undertaken, because all patients undergoing the percutaneous subclavian vein approach had also undergone an attempted cephalic vein cutdown approach.

RESULTS

In the group of 100 consecutive patients studied, median patient age was 54.5 years (range, 18–88 years). There were 46 men and 54 women. Twenty-five patients had gastrointestinal malignancies, 17 had breast cancer, 15 had lymphoma, 13 had lung cancer, 12 had leukemia, 5 had multiple myeloma, and 13 had other malignancies.

Among the 100 consecutive patients studied, 82 patients underwent successful placement of a CICVAD via the cephalic vein cutdown approach, and 18 required conversion to the standard percutaneous subclavian vein approach. In those 18 patients, there were three reasons for the inability to place a CICVAD via the cephalic vein cutdown approach: (1) the cephalic vein was too small for the catheter (10 patients); (2) there was no predominant cephalic vein, but, rather, several tiny, branching venous tributaries within the deltopectoral groove generally associated with a large, predominant artery (7 patients); and (3) it was not possible to transverse the angle of insertion of the cephalic vein into the subclavian vein (1 patient).

The procedure was performed using monitored intravenous sedation and local anesthetic in 76 patients. Eighteen patients requested general anesthesia for the procedure, and 5 patients required general anesthesia for other concurrent surgical procedures. Only 1 patient required conversion from monitored intravenous sedation to general anesthesia during the procedure.

CICVAD Placed Via Cephalic Vein Cutdown Approach

Eighty-two patients had the CICVAD placed via the cephalic vein cutdown approach. Median patient age was 52.5 years (range, 22–88 years). There were 35 men and 47 women. Nineteen patients had gastrointestinal malignancies, 17 had breast cancer, 11 had lymphoma, 12 had lung cancer, 10 had leukemia, 5 had multiple myeloma, and 8 had other malignancies.

Of the 82 CICVADs placed via the cephalic vein cutdown approach, 56 were implanted ports and 26 were tunneled catheters. Fifty-four 9.6-French BardPort implanted ports and two 6.6-French BardPort implanted ports were used. There were 20 10-French Leonard tunneled catheters and 6 12-French Hickman tunneled catheters. Thirty-eight CICVADs were placed via the right cephalic vein, and 44 CICVADs were placed via the left cephalic vein. Median operating time was 44 minutes (range, 26–79 minutes).

No immediate postoperative complications, such as pneumothorax, hemothorax, or injury to great vessels, were seen. The only immediate postoperative complication seen was a single case of spontaneous retrograde catheter migration of a right-sided 12-French Hickman tunneled catheter. In this particular case, the final position of the catheter tip was noted intraoperatively under real-time fluoroscopic guidance to be at the junction of the superior vena cava and right atrium. However, a chest radiograph taken immediately postoperatively in the recovery room demonstrated that the tip of the catheter had spontaneously migrated retrograde into the right axillary vein. In this case, transvenous retrieval of the catheter with repositioning of the catheter tip at the junction of the superior vena cava and right atrium via a femoral vein approach was undertaken. Interestingly, repeated attempts at transvenous retrieval revealed that the patient could reproducibly induce spontaneous retrograde catheter migration of the catheter tip from its initial position at the junction of the superior vena cava and right atrium and to a final position in the right axillary vein with vigorous coughing or Valsalva maneuver by causing reversal of blood flow within the superior vena cava and innominate veins. Subsequently, the catheter was removed the same day and an alternative route of central venous access (percutaneous left subclavian vein approach with a 12-French triple lumen catheter, Arrow International, Inc., Reading, PA) was established in this patient.

Median catheter duration for all CICVADs (both tunneled catheters and implanted ports) was 198 days (range, 0–513 days). Median catheter duration was 120 days (range, 0–495 days) for tunneled catheters, compared to 255 days (range, 3–513 days) for implanted ports ($P = .006$). For all CICVADs (both tunneled catheters and implanted ports), the total number of catheter days was 17,228. The total number of catheter days was 3,791 days for tunneled catheters, compared to 13,437 days for implanted ports ($P = .006$).

Long-term complications for all CICVADs (both tunneled catheters and implanted ports) have included catheter-related bacteremia, site infections (subcutaneous port pocket infections), deep venous thrombosis, subcutaneous port pocket hematoma, and superior vena cava

stricture. Catheter-related bacteremia occurred in 5 of 82 patients (6%). Four of the 26 (15.4%) tunneled catheters had catheter-related bacteremia, compared to 1 of the 56 (1.8%) implanted ports ($P = .033$). For all CICVADs, the catheter-related bacteremia rate was 0.29 episodes per 1000 catheter-days. The catheter-related bacteremia rate was 1.06 episodes per 1000 catheter-days for tunneled catheters, compared to 0.07 episodes per 1000 catheter-days for implanted ports (log rank = 8.29, $P = .004$). There were three cases of *Staphylococcus aureus* bacteremia and two cases of coagulase-negative *Staphylococcus* bacteremia. Median time to catheter-related bacteremia was 76 days (range, 36–164 days). All four of the tunneled catheters and the one implanted port with catheter-related bacteremia eventually were removed. Site infections (subcutaneous catheter tunnel infections and subcutaneous port pocket infections) occurred in 2 of 82 patients (2%). None of the 26 (0%) tunneled catheters had a subcutaneous catheter tunnel infection, whereas 2 of the 56 (3.6%) implanted ports had a subcutaneous port pocket infection ($P = .999$). For all CICVADs, the site infection rate was 0.12 episodes per 1000 catheter-days. The site infection rate was 0 episodes per 1000 catheter-days for tunneled catheters and 0.15 episodes per 1000 catheter-days for implanted ports (log rank = 0.74, $P = .391$). One subcutaneous port pocket infection was caused by *Staphylococcus aureus* and occurred 9 days after port placement. In this case, the port had been inadvertently left accessed for the entire time since the original port placement. The second subcutaneous port pocket infection was diagnosed strictly on clinical grounds (i.e., presence of erythema and tenderness overlying the port pocket site and the presence of a fluid collection within the port pocket) despite no culture-positive evidence of infection. This occurred 93 days after port placement. Both ports with a subcutaneous port pocket infection were eventually removed. In summary, catheter-related infections (including catheter-related bacteremia and site infection) occurred in a total of 4 of the 26 (15.4%) tunneled catheters, compared to 3 of the 56 (5.4%) implanted ports ($P = .200$). For all CICVADs, the overall catheter-related infection rate (including catheter-related bacteremia and site infection) was 0.41 episodes per 1000 catheter-days. The overall catheter-related infection rate (including catheter-related bacteremia and site infection) was 1.06 episodes per 1000 catheter-days for tunneled catheters compared to 0.22 episodes per 1000 catheter-days for implanted ports (log rank = 3.79, $P = .051$).

Deep venous thrombosis occurred in 4 of 82 patients (5%). All patients developing a deep venous thrombosis were determined to be hypercoagulable secondary to their primary malignancy. Median time to deep venous thrombosis was 83 days (range, 14–284 days). A significant port pocket hematoma occurred in one patient (1%). It developed 36 days after port placement as a result of iatrogenic transection of the subcutaneous portion of the attached catheter by an incorrectly placed Huber access needle, and required urgent port removal. A superior vena cava stricture occurred in one patient (1%). This was diagnosed 393 days after port placement. The port was removed at the time of balloon venoplasty of the superior vena cava.

During the 530-day study period, 30 of 82 (37%) patients died after placement of the CICVAD, and 24 of 82 (29%) of the CICVADs were removed. CICVADs were removed in 10 patients who completed treatment, 5 patients with catheter-related bacteremia, 2 patients with site infections, 1 patient with spontaneous retrograde catheter migration, 1 patient with a deep venous thrombosis, 1 patient with a superior vena cava stricture, 1 patient with a port pocket hematoma, and 1 patient with a self-iatrogenic transection of a tunneled catheter. Finally, 2 patients accidentally pulled out their own tunneled catheters.

CICVAD Placed via Percutaneous Subclavian Vein Approach

In the group of 18 patients who failed the cephalic vein cutdown approach and had CICVAD placed via the percutaneous subclavian vein approach, the median patient age was 63.5 years (range, 18–80 years). There were 11 men and 7 women. Six patients had gastrointestinal malignancies, four had lymphoma, one had lung cancer, two had leukemia, and five had other malignancies.

Of the 18 CICVADs placed via the percutaneous subclavian vein approach, 10 were implanted ports and 8 were tunneled catheters. There were 10 9.6-French Bard-Port implanted ports. There were 7 10-French Leonard tunneled catheters and 1 12-French Hickman tunneled catheter. Eight CICVADs were placed via the right subclavian vein and 10 CICVADs were placed via the left subclavian vein. Median operating time was 60 minutes (range, 36–149 minutes).

No instance of immediate postoperative complications, such as pneumothorax, hemothorax, or injury to the great vessels, was seen.

Median catheter duration for all CICVADs (both tunneled catheters and implanted ports) was 126 days (range, 5–460 days). Median catheter duration was 52 days (range, 5–136 days) for tunneled catheters compared to 277 days (range, 37–460 days) for implanted ports ($P = .001$). For all CICVADs (both tunneled

catheters and implanted ports), the total number of catheter days was 3,088. The total number of catheter days was 488 days for tunneled catheters compared to 2,600 days for implanted ports ($P = .001$).

Long-term complications for all CICVADs (both tunneled catheters and implanted ports) have included catheter-related bacteremia. Catheter-related bacteremia occurred in 2 of 18 patients (11%). Two of the eight (25%) tunneled catheters had catheter-related bacteremia, compared to 0 of the 10 (0%) implanted ports ($P = .183$). For all CICVADs, the catheter-related bacteremia rate was 0.65 episodes per 1000 catheter-days. The catheter-related bacteremia rate was 4.10 episodes per 1000 catheter-days for tunneled catheters compared to 0 episodes per 1000 catheter-days for implanted ports (log rank = 6.91, $P = .009$). There was one case of *Staphylococcus aureus* bacteremia and one case of coagulase-negative *Staphylococcus* bacteremia. Median time to catheter-related bacteremia was 92 days (range, 75–109 days). Both of the tunneled catheters with catheter-related bacteremia eventually were removed. There were no site infections, either subcutaneous catheter tunnel infections or subcutaneous port pocket infections. The overall catheter-related infection rate, including catheter-related bacteremia and site infection, was the same as the catheter-related bacteremia rate because there were no site infections. There were no cases of venous thrombosis, port pocket hematoma, or superior vena cava stricture.

During the 530-day study period, 10 of 18 (56%) patients died after placement of the CICVAD, and 4 of 18 (22%) CICVADs were removed. CICVADs were removed in two patients with catheter-related bacteremia, and two patients accidentally pulled out their own tunneled catheters.

DISCUSSION

In the present study, the cephalic vein cutdown approach for CICVAD placement was successful in 82% and unsuccessful in 18% of the patients. Previous authors[4,7,8,11,12,14,15,19] have reported a wide range of failure rates for the cephalic vein cutdown approach (Table 1). Perry et al.[12] reported that the cephalic vein route was not technically possible in only 8% of cases. Au[11] reported that the cephalic vein was too small for admission of a catheter in 17% of cases. Davis et al.[7] and Gallichio et al.[15] reported that the cephalic vein cutdown approach was unsuccessful 25% of the time. Torramadé et al.[14] reported that it was not technically possible to pass the catheter into the cephalic vein in 30% of cases. Finally, Wade et al.[4] reported that the cephalic vein route was not successful in 62% of cases.

Of those 18 patients in the present study in whom the cephalic vein cutdown approach failed, the cephalic vein was too small for the catheter in 10 patients, and 7 patients had no predominant cephalic vein (i.e., an absent cephalic vein). The finding of the present study of an 18% failure rate for the cephalic vein cutdown approach is relatively consistent with two earlier cadaver-based studies.[8,19] Chuter and Starker[8] bilaterally dissected out

TABLE 1. *Studies reporting on the failure rate of the cephalic vein cutdown approach for the placement of chronic indwelling central venous access devices*

Author (year)	No. attempted cephalic vein cutdowns	No. successful cephalic vein cutdowns	Failure rate (%)	Reason given for failure of the cephalic vein cutdown approach
Wade (1981)[4]	16	6	62	Inadequate vessels (n = 10)
Le Saout[a] (1983)[18]	263	213	19	Cephalic vein too small (n = 32) Cephalic vein absent (n = 18)
Davis (1984)[7]	32	24	25	Cephalic vein not found or unsuitable (n = 8)
Chuter (1988)[7]	43	33	23	Cephalic vein absent or too small (n = 10)
Au (1989)[10]	157	131	17	Cephalic vein, although identified, too small (n = 26)
Perry (1990)[11]	76	70	8	Inability to find cephalic vein (n = 3) Both cephalic veins already used (n = 2) Patient unable to cooperate (n = 1)
Torramadé (1993)[13]	234	163	30	Technically impossible to use this route (n = 71)
Gallichio (1994)[14]	52	39	25	Size incompatibility or difficulty passing catheter into central venous system (n = 13)
Povoski (present study)	100	82	18	Cephalic vein too small (n = 10) No predominant cephalic vein (n = 7) Inability to transverse angle of insertion of cephalic vein into subclavian vein (n = 1)

[a] This study included both cadaver-based results (n = 74 cadavers undergoing cephalic vein dissection with attempted placement of a 3.4-mm pacemaker wire) and surgical-based results (n = 189 patients undergoing placement of a 3.4-mm pacemaker wire at the time of cardiac pacemaker insertion).

the cephalic vein in 43 cadavers and found that the cephalic vein was absent or too small to pass a 6.6-French catheter in 23% of the cadavers dissected. No separate percentages for the proportion of cephalic veins that were absent or those that were too small was given. In 67% of the 43 cadavers in which the cephalic vein was absent or too small, there was no suitable cephalic vein on the contralateral side. In another cadaver-based study, LeSaout et al.[19] dissected out the cephalic vein in 74 cadavers. They found that the cephalic vein was absent in 5% and too small to pass a 3.4-mm pacemaker wire in 15% of the cadavers dissected. The cephalic vein also was bilaterally dissected out in 34 of the 74 cadavers. In 35% of these 34 cadavers in which the cephalic vein was absent or too small, there was no suitable cephalic vein on the contralateral side. In this same study, LeSaout et al.[19] also reported on dissection of the cephalic vein in 189 patients undergoing placement of a 3.4-mm pacemaker wire at the time of cardiac pacemaker insertion. They found that the cephalic vein was absent in 7% and too small to pass a 3.4-mm pacemaker wire in 8%.

Of the seven patients in the present study in whom there was no predominant cephalic vein within the deltopectoral groove (i.e., the cephalic vein was absent), a consistent finding was noted at the time of the dissection of the deltopectoral groove. In each instance, there were generally several tiny, branching venous tributaries within the deltopectoral groove associated with a large, predominant artery. This finding has not been described elsewhere in the literature.

To increase the success rate of the cephalic vein cutdown approach for placement of CICVADs, Coit and Turnbull[9] have described a modification of the Seldinger technique for insertion of a catheter into the cephalic vein when it appears to be too small to accept the catheter directly. In this technique, a 40-cm J guidewire is inserted into the cephalic vein and positioned into the superior vena cava. A No. 10 or 11 vein dilator and sheath are then passed over the guidewire and advanced into the lumen of the subclavian vein without any attempt to directly cannulate the lumen of the cephalic vein itself. The guidewire and vein dilator are then removed, and the catheter is introduced through a peel-away sheath. Despite the potential benefit of Coit and Turnbull's technique[9] for increasing the success rate of the cephalic vein cutdown approach, it was not used in the present study in those 10 patients who had a cephalic vein too small for the catheter.

In theory, the major advantage of the cephalic vein cutdown approach compared to the percutaneous subclavian vein approach is the elimination of the risks of developing immediate complications such as pneumothorax, hemothorax, and injury to the great vessels at the time of catheter insertion. In the present study, there were no cases of pneumothorax, hemothorax, or injury to the great vessels associated with the cephalic vein cutdown approach, thus supporting this theory. There are many preexisting medical conditions that could predispose an individual to development of a pneumothorax, hemothorax, or injury to the great vessels at the time of catheter insertion by the percutaneous subclavian vein approach. Preexisting medical conditions that could predispose an individual to the development of a pneumothorax would include hypovolemia, inability to tolerate the Trendelenburg position secondary to preexisting cardiopulmonary diseases, and abnormal body habitus (such as kyphosis, cachexia, or morbid obesity). Preexisting medical conditions that could predispose an individual to the development of a hemothorax or injury to the great vessel would include thrombocytopenia, coagulopathy, hypovolemia, inability to tolerate the Trendelenburg position secondary to preexisting cardiopulmonary diseases, and abnormal body habitus (such as kyphosis, cachexia, or morbid obesity). Therefore, any patient with a preexisting medical condition that would predispose that individual to the development of a pneumothorax, hemothorax, or injury to the great vessels at the initial time of catheter insertion by the percutaneous subclavian vein approach would, therefore, benefit from use of the cephalic vein cutdown approach.

In the present study, the overall catheter-related infection rate was 0.41 episodes per 1000 catheter-days for the 82 patients successfully undergoing CICVAD placement via the cephalic vein cutdown approach. The overall catheter-related infection rate, when all 100 consecutive cancer patients were included, was 0.44 episodes per 1000 catheter-days. These figures are similar to the overall catheter-related infection rates reported previously by other authors.[20–24] Three of these previous studies have clearly shown that tunneled catheters have a significantly higher catheter-related infection rate than do implanted ports.[20–22] In the study by Ross et al.,[20] the overall catheter-related infection rate was approximately 15 times greater for tunneled catheters than for implanted ports. In the study by Groeger et al.,[22] the overall catheter-related infection rate was approximately 13 times greater for tunneled catheters than for implanted ports. Finally, in the study by Ingram et al.,[21] the overall catheter-related infection rate was approximately 5 times greater for tunneled catheters than for implanted ports. In the present study, the overall catheter-related infection rate was 1.06 episodes per 1000 catheter-days for tunneled catheters (4.8 times greater, log rank = 3.79, P = .051), compared to 0.22 episodes per 1000 catheter-days

for implanted ports for those 82 patients successfully undergoing CICVAD placement via the cephalic vein cutdown approach. Likewise, the overall catheter-related infection rate was 1.40 episodes per 1000 catheter-days for tunneled catheters (7.4 times greater, log rank = 8.81, $P = .003$) compared to 0.19 episodes per 1000 catheter-days for implanted ports when all 100 consecutive cancer patients were included. Our results, showing that the catheter-related infection rate is 4.8 to 7.6 times greater for tunneled catheters compared to implanted ports, confirms those previous reports.[20–22]

In summary, the cephalic vein cutdown approach for CICVAD placement was successful in 82% of cancer patients. No immediate postoperative complications, such as pneumothorax, hemothorax, or injury to great vessels, were seen. Long-term complications of the cephalic vein cutdown approach for CICVAD placement, such as catheter-related bacteremia, site infections, and deep venous thrombosis, were relatively low and were comparable to those seen with the percutaneous subclavian vein approach in previous reports. The cephalic vein cutdown approach for CICVAD placement appears to be a safe and useful alternative to the percutaneous subclavian vein approach in cancer patients. Specifically, the cephalic vein cutdown approach may be particularly useful as the primary approach for CICVAD placement in selected cancer patients who cannot tolerate Trendelenburg positioning or who have preexisting medical conditions that may predispose them to the development of a pneumothorax, hemothorax, or injury to the great vessels by the percutaneous subclavian vein approach. Likewise, the cephalic vein cutdown approach may be a useful alternative for CICVAD placement in cancer patients who have failed the percutaneous subclavian vein approach.

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