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Ultrasound-Guided Vein Puncture *Versus* Surgical Cut-Down Technique in Totally Implantable Venous Access Devices (Tivads):

A Prospective Comparative Study on Safety, Efficacy and Complications

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Totally implantable venous access devices (TIVADs) consist of a central venous catheter (made of silicone rubber or polyurethane) and a subcutaneously-implanted injection port made of titanium or plastic, providing a simple, safe, and permanent means of accessing the vascular system for intravenous delivery of drugs and fluids.[1,2] The main advantages of these systems are to preserve peripheral vessels and to allow the patient unrestricted mobility and freedom in choice of activities.[3] This situation has led to increasing use of these systems, particularly for long-term oncologic therapies.[4–6] TIVADs can usually be implanted through 2 different ways: subclavian or external jugular vein puncture, by Seldinger technique, eventually under ultrasound (US) guidance; or surgical approach by vein cut-down (VCD) technique.[11–14] TIVADs insertion can be accompanied by intraoperative or early postoperative severe complications, such as pneumothorax, hemothorax, arterial, or brachial plexus injuries, deep venous thrombosis and pinch-off syndrome, which seem to be more frequent in cases of direct vein puncture than during surgical approach.[7–10,15–18] A recent meta-analysis showed a

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Table 1 Patient demographics and characteristics

	GROUP A (147)	GROUP B (151)	*P*
Gender (M/F)	74/73	87/64	*NS*
Mean age	56.8 +/− 13.2	53.2 +/− 11.8	*NS*
Comorbidities			
Diabetes	*23*	*31*	
Obesity	*7*	*13*	
COPD	*11*	*8*	
Cardiovascular disease	*9*	*14*	
Hypertension	*34*	*28*	
Neoplastic disease			
Gastrointestinal	*36*	*31*	
Breast	*48*	*63*	
Lung	*14*	*6*	
Gynecologic	*11*	*3*	
Hematologic	*32*	*48*	
Other	*2*	-	

similar success rate and operating time, as well as complication rates, when comparing vein puncture and surgical approach, even if serious complications such as pneumothorax were higher after vein puncture.[19] The authors present a comparative prospective study evaluating both VCD and US-guided Seldinger technique for TIVAD implantation, focusing on surgical outcome, intra and postoperative complications in 298 consecutive patients with a minimum follow-up of 180 days.

Patients and Methods

From December 2012 to September 2013, 298 patients (161 females, 137 males, mean age) were consecutively submitted, in a day-hospital setting, to TIVAD implantation in order to perform chemotherapy for solid tumor or hematologic disease, and were prospectively evaluated. Patients were divided in 2 groups, depending on TIVAD implantation technique. Group A patients (147) received TIVAD implantation by US-guided vein puncture, and group B (151) patients received TIVAD implantation by cephalic vein cut-down (CVCD) technique. TIVAD implantations were performed by 2 different teams, who were respectively skilled in percutaneous vein puncture and in CVCD technique. Patients' demographics, neoplastic disease, and comorbidities are expressed in Table 1. All TIVADs used were BardPort (Bard Access Systems, Salt Lake City, Utah, USA), with 6.5 French polyurethane catheter. All patients received single-shot preoperative antibiotic prophylaxis 30 minutes before surgery. Comparing the 2 groups, we considered the following variables: success rate, operating time, incidence, and type of complications. Continuous data (*e.g.*, age, operating time) were expressed as arithmetic mean +/− standard deviation, while data representing rare occurrence (such as complications) were expressed as numeric value and percentage in each group. Fisher's exact test was used for comparison between groups, considering significant a P value < 0.05.

Results

Intraoperative and postoperative results and complications are summarized in Table 2. In Group A patients, 121 TIVADs were implanted through the subclavian vein (11 left, 110 right) and 26 through the internal jugular vein (5 left, 21 right). The first approach was the subclavian vein in all cases, while the access to the internal jugular vein was obtained only in case of unsuccessful subclavian vein puncture. In 4 cases (2.7%), due to unsuccessful subclavian or internal jugular vein catheterization (despite US guidance), the catheter was inserted through external jugular vein cut-down technique. In 17 cases postoperative chest scan was performed in order to identify the presence of pneumothorax due to difficult subclavian vein puncture. In group B patients, 134 TIVADs were implanted through the cephalic (114, 24 left and 90 right) or coracobrachial (20, 3 left and 17 right) vein using the same skin incision used for the port insertion, while, in case of absence or nonsuitability of cephalic or coracobrachial vein, the catheter was inserted through the ipsilateral external jugular vein always by cut-down technique. No conversion

Table 2 Operative data and results

	Group A (147)	Group B (151)	*P*
Implantation site *(L/R)*	16/131	28/123	*NS*
Vein puncture			
Subclavian vein	*121 (11/110)*	-	
Internal jugular vein	*22 (5/17)*	-	
Surgical approach			
Cephalic vein	-	*114 (24/90)*	
Coracobrachial vein	-	*20 (3/17)*	
External jugular vein	4	*17 (1/16)*	
Conversion to other technique	4 (2.7%)	0	$P < 0.05$
Mean operative time	39.5 +/− 12.1	34.8 +/− 7.7	*NS*
Postoperative chest scan	17	0	*$P < 0.05$*
Complications	6 (4.08%)	3 (1.98%)	*NS*
Pneumothorax	*2 (1.36%)*		
TIVAD infection	*1*	*1*	
Catheter tip dislocation	*0*	*1*	
Hematoma	*2*	*1*	
Deep venous thrombosis	*1*	*0*	

to percutaneous vein puncture or contralateral approach, or postoperative chest scan, were needed. Mean operative time was 39.5 +/− 12.1 minutes for percutaneous vein puncture and 34.8 +/− 7.7 for vein cut-down approach, and these data showed no significant difference. Complication rate was 4.08% in Group A patients (5 cases with 2 cases of pneumothorax needing chest drain and 3 days hospitalization and 1 case of deep venous thrombosis treated with anticoagulation and subsequent TIVAD removal) and 1.98% in group B (3 cases, no pneumothorax). In 4 cases (2 of Group A, 2 of Group B), TIVAD was removed, due to wound infection, catheter tip dislocation, or deep venous thrombosis.

Discussion

Since the first implant described in 1982,[1] TIVADs have increasingly been used for long-term intravenous nutrition and drug delivery. TIVADs achieve a permanent, safe and less painful vascular access, facilitate treatment of many medical disorders, and improve patients' quality of life by giving them unrestricted mobility and freedom in their activities.[2,11] TIVADs can be implanted through either percutaneous or surgical approach.[7–14] Percutaneous access consists of a direct deep vein puncture of internal jugular vein or subclavian vein (eventually axillary vein), better under US guidance, and catheter insertion using the Seldinger technique.[15–17] This approach is the same used in cases of short-term central venous catheter or dialysis catheter implantation, and is still the most used worldwide.[7,10,15–20] Percutaneous approach has the risks of severe intraoperative complications, such as pneumothorax, hemothorax, arterial, or brachial plexus injuries, which can affect patients' outcomes. Data in the literature show that the aforementioned complications may occur in up to 12% of patients.[7,15,16,21] The use of ultrasound guidance has been demonstrated to reduce, but not to completely avoid this risk.[15,22–25] On the other hand, surgical approach with peripheral vein cut-down technique (cephalic vein coracobrachial vein or even external jugular vein), which has shown an overall risk of complication similar to percutaneous approach, is obviously not affected by risk of hemothorax and pneumothorax, due to the absence of deep vein puncture.[14–26] In about 10–12% of cases,[13,14,18] cephalic vein is not suitable for catheterization, due to anatomic variations or vein damage. In these cases we have different options: try to identify the coracobrachial vein deeper in the Morenheim fossa or place the catheter in the ipsilateral external jugular vein. This vein is superficial, quite large, and rectilineous, and it is easy to check,[14,27] placing the patient in mild Trendelenburg position. So, the combined success rate of the cephalic vein and coracobrachial/external jugular vein cut-down approach is about 100% in literature as well as in the present study.[13,14,18,19,27] Results from the present prospective study show no differences in operative time, as well as mid- and long-term results between the two groups, while there was a slightly higher incidence of complications in Group A (not statistically relevant) due to specific complications of direct vein puncture.

Conclusion

In conclusion, peripheral veins cut-down approaches for TIVAD placement are fast and safe and have a very high success rate with very low risk of complications when compared to percutaneous approach. So, this approach should be considered as a valid alternative to vein puncture approach, and the first choice in selected cases.

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