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Pneumothorax and Subclavian Vein Thrombosis in Patients With Venous Access Device Implantation

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The primary aim is to assess the length of hospitalization due to iatrogenic pneumothorax as a main complication of totally implantable venous access device (TIVAD) implantation. Secondary aim is to analyze the thrombogenic effects of different catheter diameters on the subclavian vein. Pneumothorax is a rare and may be underestimated, underdocumented, but serious complication in TIVAD of implantation using the subclavian vein puncture method. A total of 1155 consecutive patients with TIVAD implantation were assessed retrospectively over a 14-year time period. As primary outcome the length of hospitalization due to iatrogenic pneumothorax and as secondary outcome subclavian vein thrombosis (SVT) in relation to different TIVAD catheter sizes were analyzed. Pneumothoraces occurred 6 times (0.52%) and only when the subclavian vein was punctured. The median hospitalization for these patients was 8 days (5 of the 6 patients needed a chest drain). No pneumothoraces occurred when a peripheral vein was used for access (980 patients). SVTs were detected in 13 patients (1.1%) without any correlation to the diameter of the catheter. There was no significant correlation detected between the different tumor types and the complication rates. Iatrogenic pneumothorax may lead to hospitalization of 1 week or more. The costs then increase with additional chests x-rays, chest drain insertions, and hospitalization days. When making the choice for surgical venous cutdown or subclavian vein puncture to implant TIVAD, the consequences of iatrogenic pneumothorax should be considered as pneumothorax is a rare but serious complication of TIVAD implantation inherent to subclavian vein puncture.

Key words: Iatrogenic pneumothorax – Hospitalization – TIVAD – Thromboembolic complications in TIVAD

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Totally implantable venous access device (TIVAD) is of great advantage in patients requiring chemotherapy, other repetitive drug administration, or blood sampling. Iatrogenic pneumothorax is a rare but serious complication that can particularly occur when the subclavian vein is punctured to gain access for TIVAD implantation.[1–6] The percentage of iatrogenic pneumothoraces in TIVAD implantation is in general listed in the literature; however, the length of hospitalization is usually omitted.[1–11] The length of hospitalization is important in order to judge the relevance of an iatrogenic pneumothorax. A very low mortality as a consequence of central venous puncture also needs to be mentioned.[8] Therefore, the main aim of our study was to analyze the length of hospitalization due to iatrogenic pneumothorax. The secondary aim was to analyze the thrombogenic effects of different catheter diameters on the subclavian vein.[12–14]

Table 1 Patient characteristics and reason for implantation of TIVAD

Age at time of implantation, y	
Range	18–90
Mean	60.8
Distribution of sex	
M, n (%)	481 (41.6)
F, n (%)	674 (58.4)
Underlying disease	
Malignant disease	
Breast, n (%)	250 (23.43)
Lower gastrointestinal tract, n (%)	226 (21.18)
Upper gastrointestinal tract, n (%)	170 (15.93)
Blood and blood-building organs, n (%)	121 (11.34)
Respiration tract, n (%)	110 (10.31)
Pancreas, n (%)	67 (6.28)
Ovary, n (%)	53 (4.97)
Kidney and bladder, n (%)	22 (2.1)
Prostate	20 (1.87)
Cervix and uterus	16 (1.5)
Liver and gall system	12 (1.12)
Benign diseases, n (%)	88 (7.6)
Total, n (%)	1155 (100)

Material and Methods

The study was approved by the local ethics committee. A total of 1155 consecutive patients undergoing successful implantation of TIVAD between January 1, 2000, and December 31, 2013, were assessed retrospectively. There were 674 females (58.4%) and 481 males (41.6%). The age ranged from 18 to 90 years (mean: 60.8 years). A total of 1067 patients (92.4%) suffered from malignant disease as listed in Table 1. A total of 88 patients (7.6%) suffered from benign diseases, mainly hematological disorders or conditions requiring long-term antibiotic treatment.

After informed written consent, implantation of TIVAD was performed in the operating room (OR) under local anesthesia (rapidocain 1%, Sintetica AG, Mendrisio/TI, Switzerland) unless an additional procedure requiring general anesthesia was performed concomitantly. In general, the right side was chosen for implantation except when it had been compromised by previous surgery (breast, shoulder, TIVAD, or other relevant surgery) or thrombosis, especially of the right cephalic vein. Whenever possible, the patient's preferred side was selected. As a routine, a single shot antibiotic prophylaxis (cefuroxime, GlaxoSmithKline AG, Münchenbuchsee/BE, Switzerland) was given. Thromboembolic prophylaxis was not administered.

Whenever possible, the cephalic vein was the first choice for catheter insertion as the first choice; second choices were the thoracoacromial or muscular branches. If no peripheral vein could be used, the subclavian vein as third choice was punctured and the catheter was inserted with the help of an introducer set. The first needle pass was performed without ultrasound-guidance. Additional needle passes were carried out at the start of the study without ultrasound guidance and toward the end of the study all with ultrasound guidance. As a rule, not more than 5 needle passes were performed (if not successful, TIVAD implantation was planned on the contralateral side on a later day). Catheter and reservoir were always flushed with heparinized normal saline by the OR nurse. To place the tip of the catheter in the distal superior vena cava, an image intensifier was used in every procedure. Postoperative chest x-rays were only done when the subclavian vein was punctured.

Within this study, 3 different types of TIVAD were used. Between January 2000 and November 2010, it was 840 PAC II KIT W (Smiths Medical, Ashford, Kent/United Kingdom) with an outside diameter of 1.9 mm and an inside diameter of 1 mm. From November 2010 to the end of 2013, it was 307 VAS T-Port Contrast (PFM Medical, Cologne, NRW/Germany) with an outside diameter of 2.2 mm and an inside diameter of 1.6 mm. At the beginning of 2007, it was 8 T-Port 61.636.52.080-NE (Clinical plastic products SA, La Chaux-de-Fonds, NE/Switzerland) were tested, with an outside diameter

Table 2 Implanted port systems with diameter

Firm	Name	Outside diameter of catheter, mm	Inside diameter of catheter, mm	Time span
Smiths Medical	PAC II KIT W	1.9	1	January 2000–November 2010 (n = 840)
PFM Medical	VAS T-Port Contrast	2.2	1.3	November 2010–December 2013 (n = 307)
Clinical Plastic Products SA	T-Port 61.636.52.080-NE	2.6	1.6	January 2007–March 2007 (n = 8)

of 2.6 mm and an inside diameter of 1.6 mm (Table 2).

The subcutaneous tissue and skin were closed in 2 layers. A vacuum drain was never inserted. Follow-up and therapy was managed by the oncologists and local doctors. All operating reports including the unsuccessful operations (TIVAD could not be implanted) were studied. Follow-up data were generated up to date by means of electronic patient records. This implies that every additional hospital in- or outpatient appointment was documented within the electronic case notes and therefore available for follow- up.

The primary success rate for venous cutdown was analyzed as well as the overall success rate having subclavian vein puncture as a rescue by checking all the operation records.

Results

The right side was chosen for implantation in 79% (915 patients) and the left side in 21% (240 patients; Table 3).

In 980 patients, a peripheral vein could be used for catheter insertion (84.8%); 963 times the cephalic vein (83.4%; 193 left and 770 right) and 17 times another peripheral vein (1.5%) was used. The subclavian vein was punctured in 175 patients (15.2%; 43 left and 132 right; Fig. 1).

The overall success rate was 98.9%. In 13 patients, TIVAD could not be implanted on the planned side; these patients are not counted within the 1155 successful implantations (11 of these 13 patients underwent a successful TIVAD implantation on the contralateral side. A thrombosis or an iatrogenic pneumothorax did not occur in any of these 13 patients).

Table 3 Side of implantation of TIVAD

Distribution of side	N	%
Right	915	79
Left	240	21

A pneumothorax occurred in 6 cases (0.52%), but only when the subclavian vein was punctured (*i.e.*, 3.4% of all 175 subclavian vein punctures). These patients are listed in Table 4. No pneumothoraces occurred when a peripheral vein was used for access (980 patients). The median hospitalization time for patients with a pneumothorax and subsequent hospitalization following chest tube insertion was 8 days (range: 0.5–11) due to prolonged air leakage (Table 4). Five of the 6 patients suffering a pneumothorax needed a chest drain (83%). The chest tube remained for 7.5 days (range: 0–10). One patient (listed as number 3 in Table 4) with an iatrogenic pneumothorax after TIVAD implantation had a persistent air leak after 8 days requiring thoracoscopy and talk pleurodesis. The hospital time on an outpatient basis for uncomplicated TIVAD implantation was between 2 and 6 hours, unless the patients were hospitalized for another reason. There were no clinically obvious arterial injuries, no hematothoraces, and no cardiac complications. There were no hematomas requiring operative revision. As the image intensifier was used in every patient, there was no primary malpositioning.

Symptomatic subclavian vein thromboses were detected in 13 patients (1.1%). Because there were only 13 cases with a thrombosis, it is hard to detect any significant correlation with other features. The data do not indicate any association between the type of catheter and the occurrence of thrombosis. Among all patients the corresponding χ^2 test statistic was just 0.1185. Among those patients where the catheter was implanted in the subclavian vein, the χ^2 test statistic was only 0.0226.

We could not statistically detect a particular tumor type influencing complication rates.

Discussion

We performed a retrospective study on 1155 patients undergoing TIVAD implantation over a 14-year time period. Our primary access of choice was via peripheral veins in order to avoid subclavian

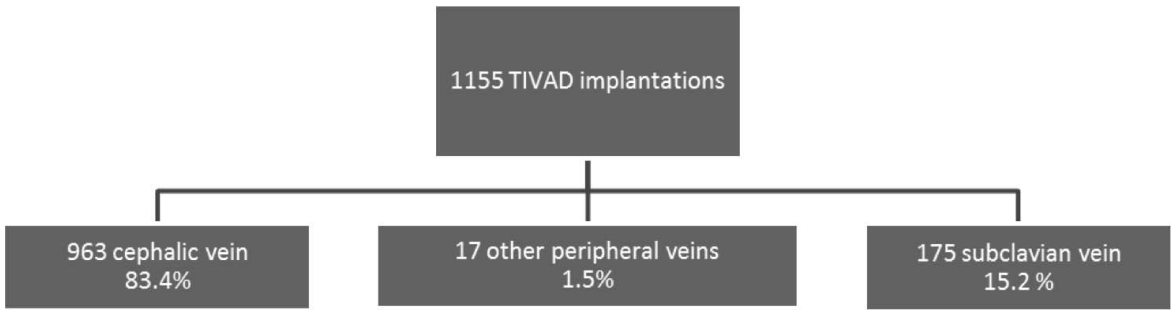

Fig. 1 Flowchart of TIVAD implantations.

puncture and iatrogenic pneumothorax. The length of hospitalization in the case of an iatrogenic pneumothorax was, in our 6 patients, more than 1 week per patient.

Primary success rate for venous cutdown was 84.8% and the overall success rate was 98.9%.

The diameter of the catheter of TIVAD did not have a thrombogenic influence among our patients. We also could not detect a particular tumor type as being more thrombogenic or influencing another complication rate.[12–14]

The choice of access vein varies between hospitals and specialists preforming TIVAD implantation.[1–6] Some centers and hospitals prefer primary access via subclavian vein puncture while others try the peripheral access first.[1–6] One access method can be the rescue for the other method in order to achieve a higher overall success rate. A recent systematic review and meta-analysis compared percutaneous subclavian vein puncture with venous cutdown for TIVAD insertion.[1] The authors reviewed the pneumothorax rate within 6 randomized trials.[1] Pneumothoraces occurred only when the subclavian vein was punctured. Hospitalization time arising from pneumothoraces was not documented.[1] Other series with large numbers of patients did not describe hospitalizations due to iatrogenic pneumothoraces.[2–6]

We believe that iatrogenic pneumothorax following subclavian vein puncture may be a rather underestimated and underdocumented complication.[1–6] There were several limitations to our study. First, it was a retrospective study and not a randomized study. The access was always via peripheral venous cutdown first and subclavian vein puncture as a rescue only. The number of needle passes was not noted.

In summary, iatrogenic pneumothoraces may cause extra hospitalization time of 1 week.

The consequences of iatrogenic pneumothoraces in subclavian vein puncture should be considered when choosing venous cutdown or subclavian vein puncture as the access method for TIVAD implantation. Pneumothorax is a rare but serious complication in TIVAD implantation using the subclavian vein puncture method and may be underestimated.

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Table 4 Patients with iatrogenic pneumothorax

Patient	Age, y	Sex	Left/right	Length of hospitalization, d	Chest tube, d	Tumor type
1	64	F	Right	7	6.5	Colon
2	77	M	Left	10	9.5	Bronchus
3	71	F	Right	11	10.5	Brest
4	58	F	Right	5	4.5	Ovary
5	51	F	Right	9	8.5	Ovary
6	63	M	Left	0.5	0	Pancreas
Median	63.5			8	7.5	

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