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Review Article

Central venous port system associated thromboses: outcome in 3498 implantations and literature review

Thrombosehäufigkeit bei zentralvenösen Portsystemen: Erfahrungsbericht über 3498 Portimplantationen im Literaturvergleich

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Abstract

Methods: From 1 July 1995 to 31 June 2006 we implanted 3498 intravenous port systems. In nearly all cases the indication was vascular access for chemotherapy.
Results: We registered 199 complications (5.7%), mostly infections (n=85 i.e. 2.4%) and thromboses (n=63 i.e. 1.8%).
Conclusions: Permanent central venous catheters have become standard in the management of patients with malignancies. Because of the improvement of material and design during the past twenty years technical complications have been reduced significantly. The most frequent occurring medical complications are infection and thromboses. In order to further minimize these disadvantages we developed a "best practices" standard for port implantation combining own data with recent studies.

Keywords: central venous port systems, associated thromboses

Zusammenfassung

Methoden: Vom 01.07.1995 bis 31.06.2006 haben wir 3498 zentralvenöse Portsysteme implantiert. In über 99% der Fälle war die Indikation ein dauerhafter, verlässlicher Zugang zur Chemotherapie.
Ergebnisse: Wir sahen 199 Komplikationen (5,7%), davon 85 Infektionen (2,4%) und 63 Thrombosen (1,8%).
Schlussfolgerung: Die Implantation zentralvenöser Portkatheter ist zum Standard beim Management von Patienten geworden, die einer Chemotherapie bedürfen. Aufgrund der Weiterentwicklung von Material und Design während der letzten zwanzig Jahre konnte die Rate an technischen Komplikationen signifikant gesenkt werden. Zu den am häufigsten auftretenden medizinischen Komplikationen zählen Infektionen und Thrombosen. Um diese Nachteile weiter zu reduzieren, haben wir einen „Best Practices"-Standard aus eigenen Daten und aktuellen Studien entwickelt.

Schlüsselwörter: zentralvenöse Portsysteme, Thrombosehäufigkeit

Introduction

Implanted central venous port catheter systems (CVC) is today an important component in the management of oncology patients. The system provides a safe vascular access with a low complication rate whereas infections as well as catheter associated thromboses are the most common observed findings [36]. However, thrombosis is a potential complication which can cause serious morbidity. In the present study we assembled and analysed the incidences of catheter-related venous thromboses among our patients. In order to further minimize the already low complication rate we summarized our experience compared to recent studies with the aim to develop a "best practices" standard for port implantation.

Material and methods

In the period between 1 July 1995 and 31 June 2006 a total of 3498 patients at the Clinic for Vascular and Thoracic Surgery at the Klinikum Ernst von Bergmann

gGmbH Potsdam underwent implantation of a CVC in an outpatient as well as inpatient setting. Out of these patients, 1889 were female and 1609 male, with an average age of 57 years (16-89 years) (Table 1). The main indication for port implantation was in 99 per cent of cases intravenous chemotherapy for patients with malignant tumours. All patients were observed and followed postoperatively as well as during the course of their inpatient stay at the clinic. Outpatients were followed at the oncology day clinic.

Table 1: Gender distribution, age and indication

Port implantations 07/95-06/06 (n=3498)	
Gender	
Female	1889
Male	1609
Average age	57 (16-89)
Indication	
Chemotherapy	3467
Others	35

Source: own compilation

Three port systems manufactured by the companies Braun (Celsite® silicon catheter: 6.5F/8.5F), Arrow (A-port® silicon catheter: 8.4F/9.6F) and Vygon (Vygon® silicon catheter: 6.6F/9.6F) were used. The preferred site of implantation was the right cephalic vein accessed through a surgical cutdown approach under local anaesthesia. The exact catheter tip position was checked intraoperatively under radiographic screening. If the implantation was impossible or not indicated on the right hand side due to lung or breast cancer the left cephalic vein was used. In case of an inapt cephalic vein we punctured the subclavian vein from the incision using Seldinger technique (n=106) or cutdown (n=196) during the same session. In the event of an impaired central venous drainage we selected in one case to implant via the right femoral vein and in another case we used the left basilic vein. In no case a port catheter insertion using the jugular vein was performed.

Administering contrast injection containing iodine was unnecessary giving the problem-free venous port implantation and the intraoperative monitoring of the function of the port. At the end of the operation the CVC was flushed and locked with heparinized saline (200 IE UFH/ml). A general thromboprophylaxis was not given. A chest x-ray in exspiration was routinely performed at the end of the procedure.

The ports were available for use immediately after implantation. Care and maintenance of the device were carried out according to the recommendations outlined in Table 2 by an experienced nursing staff.

Table 2: Care guidelines during port usage

- Puncture of the port under strict precautionary measures (aseptic technique)
- Monitoring of port function
- Use of special needles (Huber, Löffler)
- Change the port needle every 5 days when in use
- Proper fixation of the port needle
- Port to be flushed after charge of chemotherapy (10/20 syringe to avoid excess pressure)
- Heparin lock at the end of therapy (200 IE UFH/ml NaCl 0.9%)
- Change heparin lock every 4 to 6 weeks if port remains unused
- Observation of clinical symptoms as a sign for complications

Source: own compilation

Results

Between July 1995 and June 2006, 3498 venous port implantations were carried out on adult patients with malignant disease (Figure 1, Table 1). A total of 199 complications occurred listed in Table 3. The most frequently encountered complications were infections (n=85) and thromboses (n=63). We determined thromboembolic complications, all clinically relevant occlusions of central veins as well as catheter-related thrombosis demonstrated by color Duplex ultrasonography. The clinical symptomes spanned the spectrum from local problems like arm swelling, pain, malfunction of the port systems to the appearance of collateral circulation and dyspnea. A fatal pulmonary embolism or postphlebitic syndrome did not occur.

Table 3: Complications (n=199)

Early complications (< 30 days length of stay)	**30**
- Secondary bleeding (needed revision)	25 (15)
- Pneumothorax	5
Late complications (>30 days length of stay)	**169**
- Infection	85
- Thrombosis *	**63**
- Catheter disconnection	3
- Catheter dislocation	11
- Penetration of the port pocket	5
Total	**199 (5.7%)**

Thrombosis *:	**63**
- catheter related thrombosis	43
- subclavian vein	17
- axillary vein	3

Source: own compilation

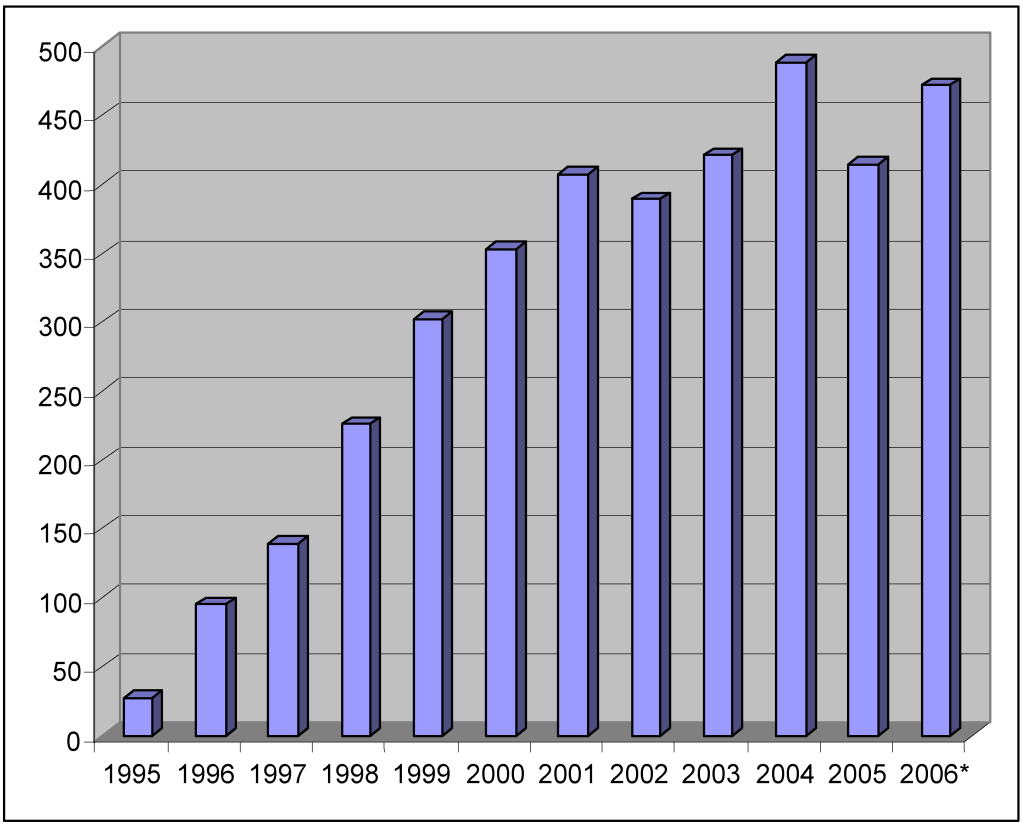

Figure 1: Port implantations 07/95-06/06 (n=3498)

Table 4: Catheter-associated thromboembolic complications in the review of recent studies

Study	Year	Patients (n)	Thrombosis	Access
Barrios [2]	1992	230	6 (2.6%)	t
Biffi [3]	2001	304	17 (5.6%)	t
Brothers [5]	1988	329	16 (4.9%)	t
DeGregorio [6]	1996	288	13 (4.5%)	t
Hofmann [12]	2006	4151	60 (1.4%)	t
Kawasaki [14]	1999	411	23 (5.6%)	p
Kock [15]	1998	1500	48 (3.2%)	t
Schauer [34]	2002	455	42 (9.2%)	p
Stein [36]	2006	3498	63 (1.8%)	t
Torramade [37]	1993	234	14 (6.0%)	t

Only studies with a patient population n>200
t = thoracic wall port, p = peripherally

Discussion

Infections and thromboses were the most often seen complications following a port implantation. A correlation of the two has been suspected by many authors [20]. Therefore we have retrospectively compared our incidence of thrombosis in CVC with recent studies. Only studies with a sufficient patient population (n>200) summarized in Table 4 qualified for our analysis.

We found a considerably high variation of the occurrence of thrombembolic complications in port systems (range between 1.4 per cent and 9.2 per cent) [12], [34]. This prompted us to work out possible risk factors in port-associated thrombosis listed in Table 5 as well as their prevention. Implantation techniques, material, time of port insertion, experience and postoperative handling can be directly influenced by the implantation team, i.e. prevention is possible. Nontheless, there are important risk factors outside of the team's control: type of malignancies, chemotherapy agents, and general risk factors (e.g. obesity, smoking, immobility, age).

Table 5: Thrombosis-related risks factors

1. Implantation technique
2. Material
3. Experience of implantation team and postoperative care
4. Point of time of implantation
5. Type of malignancies
6. Type of chemotherapy
7. General risk factors
8. Thromboprophylaxis

Source: own compilation

1. Risk factor implantation techniques

Venous thromboembolic complications occur more often in peripherally implanted venous ports than in venous chest ports. Numerous studies have shown that thoracic wall implanted ports are less prone to thrombotic episodes than armports. The stabile position, the shorter feeding path, less foreign material and a more favourable implantation procedure combined with a large lumen access vessel will reduce the incidence of thrombosis [1], [6], [7], [11], [15], [17], [19], [20], [31], [33], [36], [37].

There was further evidence that endothelial damage due to the traumatization of the Seldinger puncture wire with the vessel wall enhances the risk for thrombosis [18], [19], [20], [24], [26], [31]. This supports the open surgical port implantation procedure in contrast to the subcutaneous vein puncture technique [15], [36]. Hall et al. [8] demonstrated that catheter occlusion is more common following inexact location of the tip of the catheter in the superior vena cava. He suspected as cause an unfavourable rate of flow in addition to the danger of blood flushing the catheter. Thus, the exact catheter tip position should be checked intraoperatively under radiographic screening.

2. Risk factor material

Some current data suggest that polyurethane catheter have a lower risk for thrombosis than silicon catheter. Polyurethane catheter have a smooth surface which diminishes the adhesion of thrombocytes [7], [22]. Other studies have shown no significant difference in respect to complication rates [6], [15]. Due to lack of significant data, for the authors this question still remains open.

3. Risk factor experience of the implantation team and postoperative care

It is indisputable that a versed implantation team contributes to the reduction of the risk profile. Expedient venous cutdown and less trauma to the vein will result in a significant long term reduction of the risks of thrombosis.

Furthermore, the safe handling of the CVC is greatly enhanced by utilization of a limited number of established catheter systems. Experienced and well-trained maintenance following strict adherence to the application of care instructions (Table 2) will likewise reduce the rate of complications as many studies have shown [5], [6], [15], [16], [28], [29], [31].

4. Risk factor time of port implantation

The port implantation should be done as early as possible. At best it should be carried out at the beginning of chemotherapy. Multiple venous punctures harm the veins. Phlebothrombosis as well as already elapsed thrombotic episodes will increase the risk for thrombosis [35].

5. Risk factor tumour disease

Patients with a malignant primary disease are for a plethora of reasons subject to a higher risk of venous thromboembolism. Many factors are thought to contribute to the risk of thrombosis. These include the continuous release of blood coagulation tissue factor, changes in the composition of the haemostatic parameters (elevated fibrinogen, Factor VIII, and the PAI-Level) and damage to the endothelium [10]. Broad-based investigations demonstrated that the increased risk for venous thromboembolism is associated with different kinds of malignant diseases.

Kakkar et al. [13] showed in a study based on a survey of 3891clinicians worldwide who responded to a questionnaire that tumours of the central nervous system as well as the gastrointestinal system especially the pancreas carry a higher risk for thrombosis compared to other primary malignancies.

Levitan et al. [21] analysed a patient population of 1.2 million with malignant disease and discovered that the highest risk for thrombosis is found in patients with uterine, ovarian, brain and pancreatic malignancies as well as leukaemia.

6. Risk factor chemotherapy

The varied tumourgenicity of different chemotherapeutic agents have already been investigated. Nanninga [27] and Pritchard [30] found a significant increase in the risk for thrombosis in patients treated with CMF-chemotherapy. Doxorubicin likewise elevates the risk of thromboembolism [23].

7. General risk factors

Age above 60 years, obesity, varicose, smoking, surgical procedures and immobility are all known risk factors in the occurrence of thromboembolic complications.

8. Thromboprophylaxis

Because of the potentially dangerous effects of port-associated thrombosis many authors discussed preventive approaches utilising anticoagulants while avoiding to in-

crease the already high risk of bleeding in tumour patients.

Various studies analysed whether a low-dose of a cumarin-derivative or a low molecular weight heparin (LMWH) provides enough protection against thrombosis. The results as shown in Table 6 are controversial. Currently, a consensus exists to not recommend a general thromboprophylaxis after CVC implantation [10], [18], [38]. Further prospective investigations must be carried out to clarify this issue.

Table 6: Thromboprophylaxis

Yes	No
• Low dose NMH 1x/d [33]	• Low dose NMH 1x/d [36]
• Low dose Coumarin derivates (i.e. Warfarin 1mg/d) [34], [35]	• Low dose Coumarin derivates (i.e. Warfarin 1mg/d) [21]

Conclusions

Subcutaneous venous port devices provide a considerable facility in the care of oncology patients. The rate of complications must be acceptable even for patients in a poor state of bodily health. Through the improvement of material and design of the port catheter in the last twenty years a significant reduction of technical complications could be achieved. The task remains to diminish the most often occurring medical complications. With the inclusion of literature reviews we worked out an approach to reduce such complications even though the multifactorial genesis of the venous thromboembolism in oncology patients exacerbated the effort. Regardless factors capable of being influenced to reduce the incidence of catheter-associated thrombosis were worked on with the aim to develop a “best practices” standard for port implantation.

The preferred vascular access for port catheter implantation should be via the right cephalic vein followed by the right subclavian vein. The reasons are a sufficient large lumen of the venous access, the shortest and most favourable course of implantation and the most stabile position in the area of the thoracic wall. This will contribute to a considerable reduction in the risk of thrombosis compared to armports.

Furthermore, we recommend to use an open surgical approach in CVC implantation carried out by well-trained staff. This will result in shorter operating time and avoids damage to the endothelium through the manipulation and perforation of the wire as well as better hemostasis and avoidance of hematoma with accompanied infections. A more interdisciplinary teamwork between vascular surgeons and oncologists as well as regular training of doctors, nursing staff and patients in the handling of port systems are another important element in minimizing the complication rate.

The individual specification of a thromboprophylaxis according to the risk profile could likewise reduce the incidence of catheter-associated thrombosis. For that we need more standard prospective studies which build on the already existing management recommendations in the treatment of catheter-associated complications.

Notes

Conflicts of interest

None declared.

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