4

Long-Term Venous Access in Oncology: Chemotherapy Strategies, Prevention and Treatment of Complications

Rykov Maxim and Buydenok Yury
Institute of Pediatric Oncology and Hematology, N. N. Blokhin Cancer Research Center, Moscow, Russia

1. Introduction

Increasing the effectiveness of current chemotherapy strategies requires a higher dosage, the greater duration of treatment, multiple chemotherapy cycles, and strong adherence to recommended interval lengths between cycles. Anticancer drug administration (usually intravenously) may result in vessel wall irritation, phlebitis/phlebothrombosis, and tissue necrosis due to accidental drug extravasation. The small diameter of a peripheral vein, low blood flow velocity, easy bacterial invasion due to the proximity of the blood vessel to the contaminated skin frequently and quickly result in the aforementioned complications which render peripheral veins impossible to use as a venous access. A central venous access allows physicians to avoid most of these problems. However, its use may also lead to complications including infection, thrombosis and aeroembolism. Apart from that, multiple blood vessel punctures and a central vein catheterization for diagnostic tests, chemotherapy, maintenance treatment, and intravenous feeding have a negative effect on the quality of life. It should also be kept in mind that in pediatrics such an intrusive diagnostic method is done under general anesthesia, which is hazardous, by itself. Since a cancer treatment lasts for many months and even years, patients with traditional subclavian catheters face a significant decrease in quality of life, and experience difficulties in providing personal hygiene. This results in serious complications, the most dangerous of them being a catheter-related infection and a catheter sepsis. They are often caused by a slight shift in a catheter position, which allows the pus from the puncture wound to enter the patient's bloodstream along the outer wall of the catheter. Children may quite frequently put themselves in danger by removing an external catheter while receiving chemotherapy. It is especially dangerous if it occurs within the period of pancytopenia when the low blood count eliminates the option of a subclavian catheter, and thus an adjunctive therapy has to be given via a peripheral venous access. All the abovementioned issues may postpone the next treatment stage and ultimately have a negative effect on the whole treatment strategy and decrease its effectiveness.

Thus, the use of a totally implantable venous access system (portacath) is preferable. It is unaffected by external factors when it is not used for infusion, it is comfortable, provides a high quality of life, and is installed once lasting for the whole therapy period.

2. Materials and methods

Since 2000, more than 1500 oncological patients (aged from 6 months to 87 years) of the N.N. Blokhin Cancer Research Center have had a totally implantable venous access system installed subcutaneously.

A port is a reservoir compartment made of metal (titanium) or plastic (polysulphone). The base of a port has a device securing it in a fixed position, while the upper part contains a silicone septum, which can be punctured multiple times with a special needle for drawing blood, drug administration, and flushing the device. A catheter is attached to the side of the port with the distal end of the former located in the central vein. A dual chamber port is used when the current treatment strategies require simultaneous administration of incompatible drugs.

A port implantation requires a sterile environment, and that is why it is performed in an operating room. It is done under local anesthesia in adults and general anesthesia in children. The port can also be used for preoperative management.

Successful venous access system implantation requires an ultrasound-guided transcutaneous catheterization of the superior vena cava via an external jugular, internal jugular or subclavian vein (using a subclavicular or supraclavicular approach). An access to the superior vena cava via an internal jugular or subclavian vein (with a supraclavicular approach) is preferred to an easier traditional subclavicular approach to the subclavian vein. The latter option is undesirable, for the catheter may get lodged between the first rib and the clavicle and eventually rupture leading to drug extravasation. Another problem is connected with possibility that the catheter can be torn off.

It should be noted that an adjacent artery injury may occur during venipuncture, in which case pulsing bright red blood enters the vein under great pressure resulting in a hematoma formation and its infection. This decreases the odds of success when attempting to gain a venous access from the chosen venipuncture site.

The central vein catheterization in the neck area may also lead to an accidental puncture and trauma of thoracic duct, nerve plexus, phrenic, vagus and recurrent nerve, esophagus, larynx and trachea. Gaining a central venous access in the clavicle area bears the risk of an accidental puncture and trauma of subclavian artery, pleural cavity, lung and brachial plexus. In case of thoracic duct puncture (a rare complication of attempting to gain left-sided venous access) the catheter gets filled with milk colored fluid – lymph. The needle should be instantly removed and adequate pressure applied for 5 – 10 minutes to avoid formation of a hematoma. The subsequent venous access has to be located on the other side or as far as possible from the previous one.

A nerve plexus trauma is characterized by neurological symptoms and acute pain reminiscent of an electric shock. This complication also requires immediate needle withdrawal.

In case of an airway puncture and a lung tissue trauma, air appears in the syringe. However, this may be also due to loose connection of the syringe with the needle. As a result crepitation can be heard upon neck and thorax palpation and the patient complains of shortness of breath and chest pain caused by an increasing pneumothorax. In some patients, pneumothorax is asymptomatic and is diagnosed by thorough auscultation and X-ray examination. The outcome depends on the rate of the pneumothorax progression, its

severity and swift conversion of a closed pneumothorax to an open one by means of thoracostomy. Each central vein catheterization should be followed by chest x-ray. This allows to verify the position of the catheter and to assess the cardiovascular system.

In order to avoid the aforementioned complications a venipuncture should be performed under ultrasound control.

Successful use of an implantable venous access system is only possible when the distal end of the catheter is situated in the superior vena cava above its opening into the right atrium. The position of the catheter in the superior vena cava is most accurately determined by X-ray visualization in a cath lab or general operating room equipped with an electron-optical image intensifier. These methods are preferable in pediatric oncology for small vein diameter makes it quite hard to drive the guidewire precisely into the superior vena cava and avoid its entry into cervical veins. Accurate catheter position monitoring can also be achieved with the help of an endocardial electrogram. However, we recommend against using this method in children.

Following the catheter implantation a 2 – 4 cm incision is done below the puncture site. The length of the incision depends on the port chamber size. A special subcutaneous recess (or pocket) is made below the incision and a subcutaneous tunnel is formed using a tunneler, which is included in the implantable port kit. Afterwards the catheter is led through the subcutaneous tunnel into the port chamber with the help of a tunneler. Then the port chamber is inserted into the subcutaneous recess and fixed with interrupted sutures to the adjacent tissues and the incision is closed layer by layer. Throughout the implantation drawing some blood from the catheter or the port with a Huber needle constantly checks procedure the position of the catheter and the port. The port is ready for the infusion several hours after implantation.

The steps of the surgery are listed below:

1. Internal jugular vein ultrasound mapping;
2. Internal jugular vein puncture;
3. Guidewire insertion with radioscopic monitoring and needle removal;
4. Dilator (bougie) insertion over the guidewire;
5. Guidewire removal from the catheter and clamping of the latter to avoid hemorrhage and aeroembolism;
6. Catheter insertion into the dilator filled with normal saline;
7. Blood withdrawal and immediate catheter flushing for prevention of thrombosis;
8. Skin incision in the subclavian area below the puncture site;
9. Subcutaneous pocket formation below the incision;
10. Dilator removal (splitting);
11. Subcutaneous tunnel formation which links the skin pocket to the puncture site;
12. Catheter tunneling from the puncture site to the skin pocket and positioning in the superior vena cava under X-ray monitoring;
13. Additional blood withdrawal and catheter flushing;
14. Ligature appliance in the skin pocket and port chamber fixation;
15. Port chamber and catheter connection, and fixing it in place with a special lock;
16. Port insertion into the skin pocket and ligation;
17. Layer by layer incision closure above the port;
18. Blood withdrawal from the port chamber with a Huber needle and thorough flushing with normal saline followed by a heparin lock introduction.

The port puncture should only be done with a special Huber needle whose tip is designed to rule out the possibility of the silicon septum damage. The retrograde blood flow from the venous port upon slight aspiration is indicative of the proper infusion system functioning. Unlike regular needles, a Huber needle does not cut the silicone port septum, "spreading" it instead and keeping the system airtight for several years. The port puncture is a simple procedure, while the infusion system management requires trained staff. The port puncture can be repeated up to 2000 times provided it is performed with Huber needles which in theory allow using the system weekly for 40 years.

A visual check is needed prior to the needle insertion. If no signs of inflammation are present, the exact location of the septum is determined by palpation. Afterward while the port is kept in place between the index finger and the thumb, the needle is inserted vertically through the skin and the septum until it reaches the posterior wall of the port chamber. When accessing the port, the sterility should be ensured that implies the use of sterile gloves when performing the puncture. Modern antiseptics should be used for skin disinfection above the port and the puncture needle should be covered with disposable sterile dressing. Long presence of bacterial growth facilitating media (blood, proteins, amino acids, carbohydrates) in the port chamber and use of solutions from previously opened bottles (this especially concerns heparin) should be avoided. If needle insertion is successful, blood is drawn into the syringe upon careful aspiration. The blood (1 – 2 ml) should be disposed of and the port should be immediately flushed with 20.0 ml of normal saline. 10 ml or bigger syringes are needed in order to prevent catheter disconnection from the port chamber by excessive pressure. An incorrect insertion of the needle into the port may lead to extravasation and a fluid bleb formation in the port area.

After the infusion is complete and the needle is removed the patient can resume his normal life, bathe and even go swimming.

There are three main complications, which can pose a problem for prolonged central venous access use – thrombophlebitis at the site of the central venous catheter implantation, catheter thrombosis, and infusion system contamination with consequent infection.

The first complication is characterized by an edema, cyanosis and sometimes the hyperthermia of the upper limb and neck at the site of the venous access. Thrombophlebitis spread and progression rate is monitored with ultrasound. Chest X-ray and bacteriological study of the intravenous fluid in the catheter and port are highly recommended. The port should be removed if clinical situation allows it. In some cases it can be left in place provided the anticoagulant therapy is given promptly and contraindications are absent.

Catheter thrombosis is most likely to occur due to the venous access system mismanagement when the medical staff fails to flush the port after blood withdrawal or infusion. The preferred drug for the port flushing is urokinase – a fibrinolytic agent that activates glu-plasminogen and lys-plasminogen and converts them into plasmin, which causes enzymatic breakdown of fibrin. Fibrin mesh breakdown leads to clot disintegration and fragmentation. Clot fragments are then carried off with the blood flow or dissolved in situ. 2 – 2.5 ml of urokinase should be introduced into the system with exposure time of 15 minutes, followed by its aspiration from the portacath.

The infusion system contamination is a very dangerous condition that poses a threat of generalized sepsis. The first and rather reliable sign of the portacath contamination is high fever and algor developing 30 minutes after the introduction of normal saline into the port.

Contamination usually occurs in the infusion system inner environment and the implantation site may show no local signs even if the portacath is left unused. However, inflammation signs, often accompanied by thrombophlebitis, may be present at the site of the venous access system. The diagnosis can be verified with a bacteriological study of the fluid present in the infusion system and if it is, the venous access system has to be removed. The main cause of infusion system contamination is the medical staff's failure to comply with basic rules of infection prevention, which include washing hands and using sterile gloves and masks. One of the leading causes of contamination is multiple normal saline withdrawal from one 400 ml bottle (5 – 10 ml of normal saline are mixed with a 25000 IU heparin solution to prepare the infusion system lock). The 400 ml bottle is not changed within a shift and is stored under inadequate conditions. As a result, the absence of pharmaceutical forms for central and peripheral venous catheter flushing leads to severe complications and high costs of long-term treatment of serious catheter-associated infections. In this regard, TauroPharm's novel drug – TauroLock – is of great interest to physicians. The drug is specifically designed for flushing and locking of catheters, ports, and other long-term vascular access systems in cancer patients, patients undergoing surgery, patients with cancer, kidney failure, etc. TauroLock contains sodium citrate and taurolidine. The former is an anticoagulant and the latter is a new antimicrobial agent with a high antibacterial, antiviral and antifungal activity. The drug is so efficient in the catheter infection prophylaxis and treatment in cancer patients, that infusion system removal is not required.

According to several studies, the leading cause of catheter-associated infection in patients with a totally implantable venous access system is S. epidermidis, which is known to colonize mucous membranes and skin and contaminate the port chamber during the needle entry despite adherence to the rules of infection prevention. The authors use EMLA cream containing lidocaine and prilocaine to provide the topical anesthesia prior to a Huber needle insertion into the port chamber. The cream also has antibacterial properties provided that the exposition is 40 – 60 minutes.

3. Results

The postoperative period was uneventful with only one case of the skin pocket infection successfully treated with antibiotics. All the patients feel comfortable with having subcutaneous venous access ports. Children have no fear of catheterization prior to yet another chemotherapy cycle and are not afraid of Huber needle insertion owing to the use of the anesthetizing cream. Since the implantation, all the systems have been functioning adequately. Six patients developed the port system thrombosis, which was efficiently coped with by means of urokinase introduction into the infusion system with a 15-minute exposition. No cases of a catheter-associated infection were reported.

We use two types of solutions for port system locking between infusions – a 100 IU/ml heparin solution and Taurolock (TauroPharm, Germany), a drug specifically designed to be used as an infusion system lock.

4. Conclusion

The implantable venous port system use in cancer treatment allows physicians to reduce the number of invasive procedures, less often resort to general anesthesia, and significantly increase the patients' quality of life by offering the possibility to return to their normal lives,

i.e. to take up sports (including aquatics) and follow regular hygiene procedures. Apart from that, the port is almost unnoticeable under the skin. In the case of external venous access systems, a chemotherapy cycle could be delayed if it was impossible to gain venous access for some reason (inadequate blood count or organ failure that did not allow for general anesthesia). With the introduction of implantable port systems each chemotherapy cycle can be started on time provided that there are no other counterindications.

5. References

[1] Berezhanski B. V. Optimizatsiya farmakoterapii i profilaktiki infektsij svyazannih s tsentralnim venosnim kateterom v otdelenijah reanimatsii i intensivnoj terapii. Published summary of a thesis (candidate of Medical Science) Smolensk, 2008. p. 22. (In Russian)

[2] Gualtieri E, Deppe SA, Sipperly ME, Thompson DR. Subclavian venous catheterization: greater success rate for less experienced operators using ultrasound guidance. Vestnik Intensivnoy Terapii, 2006, №4. p 24-30

[3] Egiev V. N, Shetinin V. V., Trofimenko Y. G., Polnostju implantiruemie sistemi v meditsine. Medpraktika-M, Moscow, 2004, p 60. (In Russian)

[4] Noble V. E., Nelson B., Sutingco A. N. Manual of Emergency and Critical Care Ultrasound. Meditsinskaya literatura, 2009, p 227.

[5] Suhorukov V.P., Berdikyan A. S., Epshtein S. L. Punktsiya i kateterizatsiya ven. Traditsionnie i novie tehnologii. Posobie dlya vrachey, Sankt-Peterburgskoye meditsinskoye izdatelstvo, 2001, p 55. (In Russian)

[6] Rudolph R., Larson D.L. // Journal Clin. Oncol. — 1987. - Vol. 5. - P. 1116-1126.

[7] Fuchs R, Leimer L, Koch G, Westerhausen M. Klinische Erfahrungen mit bakteriell kontaminierten Port-a-Cath Systemen bei Tumorpatienten. Dtsch Med Wochenschr 1987;112:1615–8.

[8] Gowardman JR, Montgomery C, Thirlwell S, et al. Central venous catheter-related bloodstream infections: an analysis of incidence and risk factors in a cohort of 400 patients. Intensive Care Med 1998;24:1034–9.

[9] Timsit JF, Farkas JCH, Boyer JM, et al. Central vein catheter-related thrombosis in intensive care patients: incidence, risk factors, and relationship with catheter-related sepsis. Chest 1998;114:207–13.

[10] Daschner FD. The transmission of infection in hospitals by staff carriers, methods of prevention and control. Infect Control 1985;6:97–8.

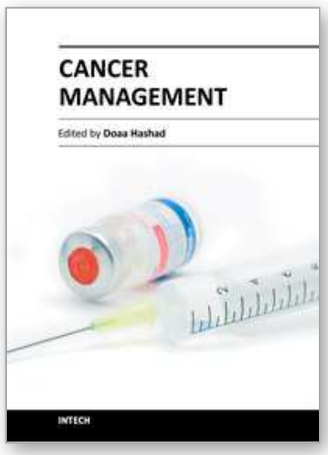
[11] Darouiche RO, Raad II, Heard SO, et al., Catheter Study Group. A comparison of two antimicrobial-impregnated central venous catheters. N Engl J Med 1999;340:1–8.

[12] Erb F, Imbenotte M, Huveene J. Structural investigation of a new organic antimicrobial: taurolidine analytical study and application to identification and quantitation in biological fluids. Eur J Drug Metab Pharmacokinet 1983;8:163–73.

[13] Gorman SP, McCafferty DF, Woolfson AD, Jones DS. Reduced adherence of micro-organisms to human mucosal epithelial cells following treatment with Taurolin®, a novel antimicrobial agent. J Appl Bacteriol 1987;62:315–20.

[14] Monson JR, Ramsey PS, Donohue JH. Taurolidine inhibits tumour necrosis factor (TNF) toxicity—new evidence of TNF and endotoxin synergy. Eur J Surg Oncol 1993;19:226–31.

[15] Leithauser ML, Rob PM, Sack K. Pentoxifylline, cyclosporine A and taurolidine inhibit endotoxin-stimulated tumour necrosis factor-alpha production in rat mesangial cell cultures. Exp Nephrol 1997;5:100–4.



Cancer Management

Edited by Dr. Doaa Hashad

ISBN 978-953-51-0650-0

Hard cover, 94 pages

Publisher InTech

Published online 13, June, 2012

Published in print edition June, 2012

Cancer remains a major clinical challenge as a cause of death due to its frequent poor prognosis and limited treatment options in many cases. Cancer management book addresses various cancer management related topics including new approaches for early cancer detection and novel anti-cancer therapeutic strategies. This book is a collection of studies and reviews written by experts from different parts of the world to present the most up-to-date knowledge on cancer management.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Rykov Maxim and Buydenok Yury (2012). Long-Term Venous Access in Oncology: Chemotherapy Strategies, Prevention and Treatment of Complications, Cancer Management, Dr. Doaa Hashad (Ed.), ISBN: 978-953-51-0650-0, InTech, Available from: http://www.intechopen.com/books/cancer-management/long-term-venous-access-in-oncology-chemotherapy-strategies-prevention-and-treatment-of-complica

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen