Coll. Antropol. **32** (2008) 3: 767–770
Original scientific paper

Central Venous Catheters for Chemotherapy of Solid Tumors – Our Results in the Last 5 Years

Mirko Žganjer[1], Ante Čizmić[1], Diana Butković[2], Martina Matolić[2], Maja Karaman-Ilić[2] and Jasminka Stepan[3]

[1] Department of Pediatric Surgery, Children's Hospital Zagreb, Zagreb, Croatia
[2] Department of Anaesthesia, Children's Hospital Zagreb, Zagreb, Croatia
[3] Department of Pediatrics, Children's Hospital Zagreb, Zagreb, Croatia

ABSTRACT

Central venous catheters provide an easy access for intravenous medications. Having a central line in place will relieve a child from the discomfort and danger of multiple regular intravenous lines for chemotherapy. The use of indwelling central venous catheters has become commonplace in the management of children undergoing oncological treatment. There are two types of central lines commonly used. There are Broviac catheters and Port-A-Cath (PAC) catheters. In the last 5 years we inserted 194 catheters in 175 children. We inserted 121 Broviac catheters and 73 PAC catheters. During the follow up of 39382 catheter days 44 complications were observed. In Broviac group the median follow up was 155 days and in PAC group was 230 days. We observed differences in the incidence between two devices. In Broviac group infections were more frequent and in PAC group other complications were more frequent than infections.

Key words: *central venous catheters, children, Broviac, Port-A-Cath (PAC)*

Introduction

A central venous access is always necessary for the management of patients undergoing high dose chemotherapy. In our hospital we used two types of central venous catheters. There were Broviac catheters and Port-A-Cath (PAC) catheters.

Broviac catheter is the most common devices in current use. They are usually manufactured from materials such as soft silicon rubber or polyvinyl chloride (PVC). They are available in a wide range of sizes for pediatric use. Broviac catheters are characterized by a variable-sized Dacron cuff which provides an anchorage in a subcutaneous tissue and may be as a microbial barrier[1].

PAC catheters are totally implantable devices. The intravascular part is made of similar material like Broviac catheters.The thick injection membrane of the system is housed in a titanium or plastic case. This provides a more acceptable cosmetic option and allows the patient to swim or bathe which are restricted practices with externally exiting catheters[2,3].

The lifetime of catheters is dependent on operative technique, sterility, catheter care, thrombosis, infections, and mechanical wear with repeated use. If we assume optimal asepsis at insertion and we carefully handle with care Broviac catheters are in use more than 18 months. PAC catheters allow 1000–2000 punctures through the thick injection membrane[4].

Broviac catheters are approximately ten times cheaper than PAC catheters but PAC catheters have many advantages.

Insertion Technique

In our operating procedures we use two different techniques. The first technique is a percutaneous procedure which is done utilising the Seldinger technique[5]. The second technique is open cut-down procedure. There are a number of different sites available for central venous catheters access. We prefer the subclavian site for catheter implantation because of the perceived clean lines and ease of tunnelling from the anterior chest wall. The better choice for implantation is the right subclavian vein because it has a shorter and more a direct route to

Received for publication June 8, 2006

the superior vena cava than the left. We always prefer the tunnelled type of catheters[6].

When we choose appropriate site, the full aseptic conditions are necessary. In general anaesthesia a flexible J-tip guidewire is passed centrally with X-ray verification. The catheters or port assembly is then tunnelled or surgically placed on the anterior chest wall. The catheter is cut to an appropriate length. This can be done by visualisation of the catheter on the anterior chest wall. A splitting sheath is passed over an introducing dilator into a central vein. The catheter is then passed through the splitting sheath which is withdrawn and peeled apart. The correct position of the intravascular part of catheter tip is adjusted under X-ray control[7,8]. The optimum position of the catheter tip is in the lower superior vena cava or upper right atrium[9].

In the operative procedure we identify the cephalic vein and with visual control the catheter it is inserted directly into the vein after venotomy. The other procedure is similar to the previously described percutaneous technique. Sometimes, it is difficult to put catheter in the lower part of vena cava because catheter migrate into the neck. In that situation it helps to pull down arm on the ipselateral side where catheter has been inserted while turning head towards the other side[10].

Complications

In our experience we observe both early and late complications. Early complications are pneumothorax[11], atrial fibrillation, aberrant catheter position in the neck and skin necrosis above catheter. Late complications are exit site infections, tunnel or port pocket infections, catheter sepsis, catheter thrombosis, deep vein thrombosis, catheter displacement or physical damage to the catheter[12,13].

Thrombosis was defined as an intravascular clot related to the catheter that either interfered with catheter function or produced signs or symptoms of vascular occlusion. Thrombosis was detected with ultrasound and/or venography when clinically suggested by progressive arm or facial swelling. Infection was defined by positive blood culture results in the setting of systemic symptoms consistent with infection that was not attributable to another source[14,15].

Port pocket infection and tunnel infection was defined as induration, erythema and tenderness around the port or subcutaneous catheter tunnel with culture positive material aspired from the port pocket or tunnel[16,17].

Results

In the last 5 years two different devices were inserted. We inserted 121 Broviac catheters and 73 PAC catheters. During the follow up of 39382 catheter days 44 complications were observed. In Broviac group the median follow up was 155 days and in PAC group was 230 days. In Broviac group 30 complications were observed and 14 complications were observed in PAC group. The age of the patients at the time of surgery varied from 3 months to 20 years. The mean age of patients with inserted catheters was 5 years old.

Early complications

A pneumothorax was observed as a complication in three patients (3/194; 1.54%). Only one patient required a tube thoracostomy to treat a large pneumothorax. One patient had a port and two had Broviac catheters.

Two patients with Broviac catheters (2/194; 1.03%) experienced atrial fibrillation as a consequence of central venous catheter. It was successfully treated with catheter removal and re-implantation on the opposite side.

The correct position of the intravascular part of catheter tip is adjusted under X-ray control. Sometimes, it is difficult to place the catheter in the lower superior vena cava because catheter goes up the neck veins. In this situation the previously mention manoeuvres are usually successful to reposition the catheter tip. In our experience we had no catheters with tip position in the neck after operative procedure. In one patient (1/194; 0.52%) with PAC skin necrosis developed ten days after implantation and required catheter removal.

One patient had an accidental arterial puncture during the implant procedure which did not cause any significant complication.

Late complications

The most common complications of central venous catheters were infections. These infections can be divided into three main groups which may coexist: exit site infection, tunnel or pocket infection and catheter sepsis or catheter-related bacteraemia.

Exit site infections were localised to the point at which a device exits through the skin. We had 7 patients (7/194; 3.6%) with Broviac catheters which had exit site infections. Five (5/194; 2.57%) of them had infections due Staphylococcus epidermidis and local wound care with antibiotics and without catheter removal can be managed. Two patients (2/194; 1.03%) had evidence of bacteremia and more virulent pathogen such Staphylococcus aureus, such treatment may not be adequate. Antibiotics were initially administered. When bacteremia persisted removal of catheter was eventually required in one patient.

We had five patients (5/194; 2.57%) with tunnel or pocket infections, two patients (2/194; 1.03%) with Broviac and three (3/194; 1.54%) with port catheters. This represents a process of suppuration or induration related to subcutaneous tunnel (or pocket in the case of port). Because of the presence of suppuration and foreign body, these infections required the catheter removal and antibiotics.

The most serious type of infections was sepsis. We had eight patients (8/194; 4.12%) with these type of infections including Enterobacter, Acinetobacter, Staphylococcus, Candida and Enterococcus bacteremia. When sepsis was defined antibiotics were administrated. Cath-

eter was removed only when antibiotics treatment were deemed inadequate. Five patients (5/194; 2.57%) with Broviac and three patients (3/194; 1.54%) with PAC had sepsis[18,19]. In four patients catheter were removed because antibiotic treatment was insufficient.

Thrombosis was defined as an intravascular clot related to the catheter that either interfered with catheter function or produced signs or symptoms of vascular occlusion. In our experience we observed only subclavian and axillary thrombosis with swelling of the arm. We had one patient (1/194; 0.52%) with PAC and two (2/194; 1.03%) with Broviac catheter that had deep vein thrombosis. Deep vein thrombosis occurred after infections and with catheters which were in place 10 months and more. Another aspect of catheter thrombosis is intraluminal thrombosis which leads to obstruction to infusions or blood administration and withdrawal of blood for analysis. This complication can usually be prevented by a heparin injection. Catheters are flushed with heparinized saline after each use. Various solutions and strategies have been used to aid unblocking of catheters. These include heparin, urokinase and streptokinase. Aspiration of the air from the lumen to create vacuum followed by connection to a syringe containing the fibrinolytic agent[20,21]. We had two patients (2/124; 1.03%) with PAC and three patients (3/194; 1.54%) with intraluminal Broviac catheter thrombosis. Catheters must be removed only when anticoagulation or thrombolysis are inadequate. We only removed 2 catheters due to this complication.

TABLE 1
EARLY AND LATE COMPLICATIONS

Complications	Broviac	Port-A-Cath (PAC)
Pneumothorax	1	2
Atrial fibrillation	2	0
Necrosis cutis	0	1
Exit site infections	7	0
Tunnel /port infections	2	3
Sepsis	5	3
Deep vein thrombosis	2	1
Catheter thrombosis	3	2
Drug extravasation	4	2
Catheter pull out or cut	4	0
Total	30	14

In two (2/194; 1.03 %) PAC catheters we had extravasation of drugs because catheters broken in the proximal portion. This complication was seen in four (4/194; 2.06%) Broviac catheters. Catheters were removed only in one patient where we noticed skin necrosis.

In four patients (4/194; 2.06%) with Broviac we had accidentally pulled out the catheter or cut catheter with scissors and only treatment was removal of the catheters (Table 1).

Discussion

In this observational study of 194 implanted CVC, for a total of 39382 catheter days we described insertion technique and complications in a 5 year period. Infections represent more frequently reported complication. We had 20 patients (20/194; 10.31%) with all kinds of infectious complications. Ten patients did not require catheter removal because of successful antibiotic treatment. The other 10 patients with infections required the catheter removal because antibiotics treatment were deemed inadequate[22].

The second complication in our study was thrombosis. We had 8 patients (8/194; 4.12%) with thrombotic events. All patients received thrombolytic drugs through the catheters, depending on the patient's coagulation profile. In all 3 patients (3/194; 1.54%) with deep vein thrombosis catheters were removed, and in patients with intraluminal catheter thrombosis two patients required catheter removal.

The third complication in our study was mechanical complications such as catheter dislodgement and damage to the catheter. We had 10 patients (10/194; 5.15%) with mechanical complications. The best prevention of this type of complications are education of hospital staff and parents on how to handle and care for catheters.

Conclusion

PAC catheters provided a more acceptable cosmetic option and allows the patient to swim or bathe which are restricted practices with externally exiting catheters. Broviac catheters are approximately ten times cheaper than PAC catheters. In our hospital we try to insert PAC to patients with long-term chemotherapy when it is possible because port catheters have more advantages than Broviac (low percentage of complications, better cosmetic effects, easy every day life and requires no care by patients)[23].

To avoid early complications it is necessary to improve surgical technique and have an excellent team. To avoid late complications and the best prevention of these complications it is necessary to educate of hospital staffs and parents how to handle and care of catheters.

REFERENCES

1. BROVIAC LW, COLE JJ, SCHRIBNER BH, Surg Gynecol Obstet, 136 (1973) 602. — 2. LOH AH, CHUI CH, Asian J Surg, 30 (2007) 193. — 3. URREA M, RIVES S, CRUZ O, NAVARRO A, GARCIA H, ASTELLA J, Pediatr Hematol Oncol, 23 (2006) 459. — 4. FRATINO G, MOLINARI AC, MAZZOLA C, J Pediatr Hematol Oncol, 24 (2002) 657. — 5. AMEH V, JONES S, Emerg Med J, 24 (2007) 662. — 6. ARAUJO CC, LIMA MC, FALBO GH, J Pediatr (Rio J), 54 (2007) 64. — 7. HSU, JH, WANG CK, CGU KS, CHENG KI, CHUANG HY, JAW TS, WU JR, Acta Anaesthesiol

Scand, 50 (2006) 731. — 8. GEBAUER B, TEICHGRABER UK, PODRABSKY P, WERK M, HENNINEN EL, FELIX R, Cardiovasc Intervent Radiol, 30 (2007) 668. — 9. STONELAKE PA, BODENHAM AR., Br J Anaesth, 96 (2006) 335. — 10. GUTH AA, Am Surg, 67 (2001) 26. — 11. KARAPINAR B, A.CURA, Pediatr Int, 49 (2007) 593. — 12. POLDERMAN K, GIRBES A, Intensive Care Med, 28 (2002) 1. — 13. FRATINO G, MAYYOLA C, BUFFA P, Pediatr Hematol Oncol, 18 (2001) 317. — 14. JOURNEYCAKE JM, BUCHANAN GR, Curr Opin Hematol, 10 (2003) 369. — 15. DUBOIS J, RYPENS F, GAREL L, DAVID M, LACROIX J, GAUVIN F, CMAJ, 177 (2007) 1185. — 16. LORENTE L, VILLEGAS J, MARTIN MM, JIMENEY A, MORA ML, Intensive Care Med, 30 (2004) 1681. — 17. POLDERMAN K, GIRBES A, Intensive Care Med, 28 (2002) 18. — 18. ADLER AA, YANIV I, STEINBERG R, SOLTER E, SAMRA Z, STEIN J, LEVY I, J Hosp Infect, 62 (2006) 358. — 19. VILELA R., JACOMO AD, TRESOLDI AT, Clinics, 62 (2007) 537. — 20. DEBOURDEAU P, ZAMMIT C, PAVIC M, BENSAID B, FARGE-BANCEL D, Rev Med Interne, 28 (2007) 471. — 21. ABDELKEFI A., BEN OTHMAN T, KAMMOUN L, CHELLI M, ROMDHANE NB, KRIAA A, LADEB S, TORJMAN L, LAKHAL A, ACHOUR W, BEN HASEN A, HSAIRI M, LADEB FBEN ABDELADHIM A, Thromb Haemost, 92 (2004) 654. — 22. ADLER AA, YANIV I, SOLTER E, FREUD E, SAMRA Z, STEIN J, FISHER S, LEVY I, J Pediatr Hematol Oncol, 28 (2006) 23. — 23. NG F, MASTOROUDES H, PAUL E, DAVIES N, TIBBALS J, HOCHHAUSER D, MAYER A, BEGENT R, MEYER T, Clin Oncol (R Coll Radiol), 19 (2007) 551.

M. Žganjer

Department of Pediatric Surgery, Children's Hospital Zagreb, Klaićeva 16, 10000 Zagreb, Croatia
e-mail: mirko.zganjer@zg.htnet.hr

CENTRALNI VENSKI KATETERI U TERAPIJI SOLIDNIH TUMORA – NAŠI REZULTATI UNAZAD 5 GODINA

S A Ž E T A K

Centralni venski kateteri omogućuju lakši pristup parenteralnom liječenju onkoloških bolesnika. Postavljenim centralnim venskim kateterom oslobađamo dijete psihičkih trauma i boli tijekom liječenja. Ugradnja centralnih venskih katetera su postala uobičajeni postupak pri liječenju onkoloških bolesnika. Najčešće se upotrebljavaju dvije vrste katetera i to Broviac kateteri i Port-A-Cath (PAC) kateteri. Unazad 5 godina ugradili smo 194 katetera kod 175 djece. Ugradili smo 121 Broviac kateter i 73 PAC katetera. Tijekom praćenja kroz 39382 dana koliko su ukupno kateteri bili ugrađeni zamijetili smo 44 komplikacije. Prosječna dužina trajanja Broviac katetera je bila 155 dana, a PAC katetera 230 dana. U tijeku ove studije smo promatrali razlike između dvije vrste katetera. U grupi Broviac katetera najučestalije su bile infekcije dok su u grupi Port katetera učestalije bile druge komplikacije.