Case report

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Fracture and migration in right atrium of a permanent venous central access system in a elderly patient: case report and literature review

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Abstract

Catheter dislocation and fracture with migration of central venous lines have been reported in the International literature. Catheter fracture with consequent migration has been observed in 0.5-3.0% and may either be consequent to catheter removal or it can occur spontaneously. Our case report concerns the migration of a Hickman catheter connected to a venous port to the right atrium in a 61-year old patient. A literature up-to-date has been performed to assess the risk of port-a-cath positioning. The position of catheter tip is considered critical for the risk of migration, that is greater as higher the tip localization respect to the carina. The aim of our study is to underline the critical role of X-ray to visualize the exact location of the catheter tip, regardless of the approach used for catheter positioning. ***Clin Ter 2022; 173 (3):207-213 doi: 10.7417/CT.2022.2419***

Key words: *Port-a-cath dislocation, port-a-cath migration, port-a-cath complications*

Introduction

Totally Implantable Venous Access Devices (TIVADs) can be inserted through a percutaneous or surgical approach, which may cause early or late complications (1).

The complications of TIVAD positioning could be grouped into four classes: infective, thrombotic, mechanical and those due to extravasations of fluid around the reservoir (2). Mechanical complications include catheter dislocation and fracture with migration. Catheter fracture with consequent migration has been described in 0.5-3.0% of patients and may either be consequent to catheter removal or it can occur spontaneously (3).

We report the case of migration of a Hickman catheter connected to a venous port into the right atrium. A comprehensive literature revision was performed to assess the early and late complications of this procedure.

Case Report

A 61-year old Caucasian woman affected by metastatic breast cancer was admitted to our Institution for implantation of a fully implantable venous system for chemotherapy. Hematochemical tests were within the normal range. The system was surgically implanted under local anesthesia. Post-proceduralchest X-raydemonstrated the correct catheter positioning with the tip located at the junction between the superior vena cava and the right atrium. Postoperative course was uneventful. During chemotherapy administration 4 months later, the infusion was interrupted because a leak of the drug was noted. A chest X-ray was immediately performed, which showed the fracture of the catheter into two parts at the level of its connection with the reservoir. The distal part was located in the right atrium and was partly twisted whereas the proximal part was floating in the left subclavian vein. A percutaneous access through the left femoral vein allowed the endovascular removal of the fragment migrated in the atrium and the port was explanted.

General review of literature

Central Vein Catheters

Patients affected by cancer and treated ambulatory often need venous access. This may be due to cases of electrolyte imbalances, malnutrition and renal failure, poor venous access, involvement of drugs known to be venous sclerosants in the intravenous therapy, repeated sampling or venesection (4-7). Long-term central venous catheters (CVCs), including

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tunneled central venous catheters (TCVCs) and totally implanted devices or ports (TIDs), can be used in order to limit the discomfort of short-term venous access(8). Catheters are generally categorized into non-tunneled catheters, tunneled catheters with anchoring cuff, implanted ports, apheresis/dialysis catheters (tunneled and non-tunneled) and peripherally inserted central catheters (PICCs). They may have single or multiple lumina and can be open ended or valved (9,10).

Implantation technique

The patient is placed in a supine position. The operator decides the side of skin puncture. The right side is generally chosen. The ipsilateral anterior superior region of the chest is shaved and sterilized with povidine-iodine or clorexidine. The procedure is performed under sedation and local anesthesia, 1% lidocaine, is injected at the infraclavicular puncture side. The subclavian vein is punctured with a proper gauge needle, 2-3 cm medial to the midpoint of the clavicle. A guide wire is passed through the needle into the vein and the needle is removed. A vein-dilator is passed over the guidewire. The guidewire is removed and the catheter passed over the wire under fluoroscope guidance. The distal tip of the catheter is passed through the subcutaneous tissue with the help of a tunnellizer approximately 3-4 cm caudal to the puncture site. The correct catheter position is guaranteed under fluoroscope guidance when the catheter tip is seen in the superior vena cava (SVC) and by the free flow of blood through the catheter into the syringe (11-14).

In case of ports, a 2 cm incision is done two fingers below the mid aspect of the clavicle. A cavity is done in the subcutaneous tissue to accommodate the port chamber. A tunnel is made between the cavity and the puncture site and the catheter is passed through. The tip of the catheter is then adjusted to the level of the junction between the SVC and the right atrium under fluoroscopic guidance. The catheter is then connected to the port chamber with a plastic or metallic lock. The port is tested with heparinized saline (aspiration and then injection). The subcutaneous tissue is closed with absorbable suture followed by closure of the skin bynon-absorbable suture.

After the procedure, a chest X-ray is performed to determine the position of the catheter tip and to exclude pneumothorax.

TIVADs

TIVADs are totally implantable venous access device consisting of a conventional central venous catheter attached to a subcutaneous injection port usually on the chest wall (15).

Related immediate complications occur between the time of placement and before the first catheter use, while late complications occur in the subsequent period (16). Accordingly, complications can be divided into perioperative and long-term complications.

Perioperative complications

Perioperative complications are mostly related to access vein puncture and catheterization.

Pneumothorax

Attempts to cannulate the subclavian veins can lead to pleural puncture with subsequent pneumothorax. The vast majority of patients remain asymptomatic and hemodinamically stable (14). Rest and oxygen therapy can be the only treatment, but serial X-rays are necessary. Otherwise, if the patient develops tachypnea, tachycardia, or cannot maintain baseline oxygenation on high flow oxygen mask, a chest tube thoracostomy may be necessary.

Arterial puncture or catheterization

Attempts to cannulate subclavian or internal jugular vein can lead to subclavian artery or carotid puncture, respectively, due to several conditions such as difficult venous anatomy, inadequate position of the patient, obesity or inexperience (17). It should be noted, though, that the routinely use of ultrasonography has significantly reduced the incidence of this complication. If arterial puncture has been suspected by a pulsatile backflow or arterial blood trough the needle, removal of the access needle and compression may be sufficient. Interventional radiology techniques or surgery may be needed in case of longlasting arterial catheterizationor if large introducers have been used.

Arrhythmias

Arrhythmias can arise during Seldinger's catheterization of the access vein, due to the guide wire being introduced deep near the atrio-ventricular node. Easily detected during standard cardiac monitoring, these arrhythmias are generally benign and a simple pull back of the wire is sufficient to restore normal conduction (18).

Hemorrhage

Hemorrhage with consequent hematoma may be more frequent in case of hematologic disorders, coagulopathies, anticoagulated patients or if platelet count is less than 50x10^9/L. In these conditions, specific measures should be taken in order to reduce the risk (19). In most cases, hematomas occur at the puncture site and are clinically irrelevant; bleeding is controlled by manual compression. To lower the risk of hemorrhage, anticoagulation should be switched to unfractionated heparin and should be stopped in the time frame starting 3 hours before catheter insertion and ending3 hours after the procedure, when hemostasis is secured.

Air Embolism

The production of air bubbles happens more frequently in the vascular structures of the subarachnoid space, which is interpreted by some Authors as intra-arterial and by others as intra-venous. This event usually occurs during the interval between removing the dilator and peeling away the sheath and is often associated with problems in placing the catheter into the sheath. It may also occur inadvertently by

injecting air bubbles during the catheter flushes or heparin injections (20). Evidences hypothesized three mechanisms: 1) ischemia due to interruption of cerebral arterial flow, which is supported by the finding of cytotoxic edema; 2) ischemia due to blood flow change in intracranial venous sinus or cortical veins, promoting vasogenic edema and venous infarctions; 3) inflammation due to breakdown of blood–brain barrier and activation of immune cells and inflammatory proteins, which is supported by the finding of vasogenic edema without recent ischemic lesions (21-23). In addition to supportive therapy with oxygen, preferably by a facemask or 100% non-rebreather mask, the recommended specific treatments for cerebral gas embolism include closing the entryway of air, aspiration of the CVCs, Trendelembourg positioning, and hyperbaric oxygen (24). Air embolism is usually self-limiting and the symptoms resolve in few minutes, although outcomes of large gas emboli are associated with bradycardia, high morbidity, and mortality.

Late Complications

Late complications in central venous access may be of infectious, thrombotic, and mechanical nature.

Infection

Central line-associated bloodstream infections (CLABSI) remain a leading cause of serious health care-associated infections (25-26). The most commonly microorganisms identified in catheter-related infections are: coagulase negative Staphylococcus, Staphylococcus aureus, Candida species, which are primarily skin organisms, enteric gram-negative bacilli, and Pseudomonas aeruginosa (27). In recent years, some programs focused on improving adherence to evidence-based standards of care: chlorhexidine-based antiseptic use, maximal barrier precautions, antibiotic-impregnated catheters, use of checklists, and others. They have succeeded in improving overall CLABSI rates significantly, especially in intensive care units and in pediatric patients (28). The Healthcare Infection Control Practices Advisory Committee and the Institute for Healthcare Improvement of the United States of America recommend the adoption of bundles or "Intervention Packages". These are combinations of practices and behavior for the prevention of microbial contamination, the migration and adhesion of microorganisms, and catheter colonization, that help reducing both the rate of infection and the ID of sepsis, according to evidences(29-30). Other factors contributing to the increased risk of infections include prolonged CVC use, as well as the overlooking of best practices related to its insertion and maintenance. These practices include hand washing, use of maximum barrier precautions, use of chlorhexidine for skin antisepsis, selection of the best site for CVC insertion, and daily catheter assessment, in addition to its removal as soon as it is no longer necessary. As an important preventive measure against infections, it is now strongly recommended that CVC should be withdrawn within 7 days after insertion. Moreover, maintenance bundles or checklists or procedures should be followed in prolonged use (31-32). If there is a need to extend catheter utilization beyond 7 days, infection surveillance should be increased, and the health care team must receive training regarding care during CVC manipulation, including the daily assessment of the catheter requirement, dressings and handling for the administration of solutions, and the use of a specific checklist for CVC maintenance (33).

Catheter Malfunction

Paying attention to tip positioning either at the cavo-atrial junction or in the mid right atrial chamber in order to minimize catheter malfunctions:

- *Fibrin or thrombus occluding the end hole*
- *Catheter malposition or migration*
- *Catheter fracture or disconnection*

Fibrin Sheath

Fibrin sheaths cover all catheters within 1 week of placement. In some instances, the sheath or sleeve covers the end-hole of the catheter, causing occlusion. Fluid can usually be injected, but blood cannot be aspirated. Hemodialysis or apheresis catheter dysfunctions are seen with diminished blood flow rates (34-35). Using low-dose fibrinolytic agents is usually considered as a first line of management. Recent studies showed that catheter lumens can be filled with 2 mg of alteplase, with a dwell time of 60 minutes, after which vigorous aspiration with a syringe must be attempted (36-37). Repeating this technique 1 or 2 times can generally salvage the catheter, at least temporarily. Alternatively, the catheter can be infused with 2 mg of alteplase in 50 mL of normal saline at a rate of 17 mL/h (38-39). If the low-dose fibrinolytic agents have been unsuccessful and the catheter cannot be exchanged readily, such as in ports, fibrin sheath stripping should be performed (40-41).

Catheter Migration

Occasionally, catheter migration may occur in long-term central catheter, despite correct initial positioning. The catheter tip can end up in various locations, both intra- and extravascular (42). The most common sites are internal jugular, brachiocephalic, or azygous veins. Rarely, the catheter tip can erode the vein wall and become extravascular (43-44).

Catheter Fracture

Catheter fracture, with or without subsequent migration, tends to occur when catheters have been in place for long periods. The mechanical forces acting on the catheter between the first rib and the clavicle are the most frequent source of fracture. Intravenous catheter fracture and embolization has been discussed in the literature since the early 1950s (45). Fracture of a centrally implanted venous catheter is a very rare complication with an estimated prevalence of 0.2-1%

(46). In 1984, Aitken et al. proposed that 'pinching' of the catheter between clavicle and first rib over time could lead to late fracture and embolization of the distal segment into heart and great vessels (47-49). Evidences showed that only a minority of patients with catheter embolus present with significant symptoms, including chest pain, palpitation, arrythmias, and unstable vital signs (50-51). The key to the diagnosis remains chest X-ray. Catheter embolus should be removed as soon as it is diagnosed, by less invasive methods such as transcutaneous retrieval, preferably through a femoral vein approach (52-54). Failure of interventional radiologic techniques may rarely necessitate thoracotomy and cardiothomy to remove the fractured segment (55-58). In other cases, a catheter fragment in the heart may remain asymptomatic for years.

Venous Thrombosis

The rate of thrombosis varies in literature from 0.027 episodes for central venous catheter-year to 6% (59-60). The risk of catheter-related thrombosis varies according to the site of insertion. The patient can develop head and neck swelling with SVC stricture or thrombosis such as SVC syndrome and upper extremity swelling may also be seen. Skin discoloration is sometimes seen with numbness and tingling (61). Before administration of chemotherapeutic agents,a standard safety test should be undertaken, consisting in blood aspiration followed by heparinized saline injection (62-64). Doppler sonography or contrast venography are used to diagnose catheter-related venous thrombosis.In case of symptoms, the initial treatment is systemic anticoagulation. If the symptoms do not improve in 1-2 days, the device should be removed and catheter-directed thrombolysis should be considered (65). Extending catheter-directed thrombolysis over 48 hours will increase the systemic risks of hemorrhage, and it is thus discouraged. In cases catheter-directed thrombolysis is partially successful or unsuccessful, angioplasty or possibly venous stenting can be performed. However, the long- term results of these therapies are poor as the veins remain prone to thrombosis (66).

Ultrasonography (US) and ports

Recent evidences showed that routine use of ultrasound and fluoroscopy has led to lower immediate complication rates, which range from 4% to 7%. US-guided CVC placement has lowered the failure rate for catheterization, the mean number of passes, the mean time to cannulation, and the rate of complications (67). US guidance can be performed in static or dynamic fashion. The static method of US guidance consists in identifying vascular anatomy and determining the location on the skin where to insert the needle; the dynamic method consists in visualizing the needle entering the vessel. The success rates of catheter insertion are improved by adopting static or dynamic US guidance, when compared to the landmark method (68-69). Since a high number of passes will disrupt the endothelial lining of the vessel, US guidance also indirectly decreases the rate of catheter-related thrombosis, catheter patency loss, rupture, or tip dislocation (70-72).

Discussion

We underline the critical role of the radiological data to visualize the exact location of the catheter tip, regardless of the approach used for catheter positioning. Infusion problems through the reservoir should always suggest that some complication related to the catheter have occurred. When a complication is suspected, a chest X-rays should be done, since it is able to identify catheter fracture, pinch off or kinking and the proper connection of the catheter to the reservoir.

We believe that the cephalic vein should be preferred for a fully implanted systembecause the catheter may follow a straighter route and kinking is less likely to occur. Migration of catheter may occur days or months after its positioning. The catheter tip may spontaneously move from the SVC to another location in the venous system. Authors report an incidence of this phenomenon ranging from 5 to 55% (5). The most frequent sites of secondary migration of the catheter's tip from the SVC are the ipsilateral internal jugular vein (43%); the axillary vein (19%), the contralateral innominate vein (11%) and the right atrium (9.5%). The mechanism is unclear. Many hypotheses have been made and risk factors have been identified, such as forced catheter flushing, intense upper arm movements, neck pushups, and heart failure. Moreover, conditions where chest pressure is increased, such as vomiting, or mediastinal lymphadenopathy and caught related to lung cancer, have been correlated with an increased risk of catheter migration (73,74). Position of the catheter tip is considered critical for the risk of migration. In particular, it is positively correlated with a higher localization of the tip with respect to the carina, confirmed by a fluoroscopy (4).

The percentage of complications related to the presence of permanent venous lines range from 10% to 15% (6,8). Spontaneous catheter fractures have been reported for catheters implanted through the subclavear route into the subclavian vein. In this case, the compression of the catheter by the clavicle and the first rib (pinch off) cause catheter fracture (8,9,11). Other mechanisms involved in intravascular catheter migration are misconnection of the catheter with the reservoir and defects of fabrication (6,12-13). In our case report, catheter fracture has been identified ten days after trauma because of the solution leaking into the chamber during an infusion of chemotherapy medications. Chest X-rays clearly show the fracture and the migration of the catheter in the right pulmonary arteria, which was not causing any relevant symptom.

Conclusions

Catheter fracture and migration is treated using an angio-radiological via with percutaneous approach rather than sur-

gical removal through thoracotomy. In our case, the catheter fragment was removed using a percutaneous access through the left femoral vein, without further complications.

In conclusion, the growing use of the implantable systems requires to rise the knowledge about possible mechanisms implicated in the development of complications in order to inform the patient and make the medical and nonmedical staff able to manage these systems and to promptly identify life-threating complications.

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Competing Interest

All authors have no conflict of interests.

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Authors contribution

Sergio Gazzanelli: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Michelangelo Miccini: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Paolo Sapienza: Participated substantially in data collection, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript.

Giuseppe Cavallaro: Participated substantially in data collection, and execution of the study and in the analysis and interpretation of data.

Daniele Biacchi: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript, and critical revision of the paper.

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Carolina Guerra: participated substantially in data collection, and execution of the study and in the analysis and interpretation of data.

Marco Vito Ranieri: Participated substantially in conception, design, and execution of the study and in the analysis and interpretation of data; also participated substantially in the drafting and editing of the manuscript, and critical revision of the paper.

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