Causes of Fracture at Catheter of Totally Implantable Venous Access Port: A Systematic Review

Wala Ben Kridis, Nabil Toumi, Afef Khanfir

Department of Medical Oncology, Habib Bourguiba University Hospital, Sfax, Tunisia

Received: 28 Mar. 2019; Accepted: 11 Dec. 2019

Abstract- A totally implantable venous access port (TIVAP) plays a crucial role in the treatment of patients in oncology. Catheter fracture is a serious complication with an estimated incidence of 0, 1% - 1%. The objective of this systematic review is to analyze the mechanism of TIVAP fracture to make physicians aware of this fatal entity. A search of the literature between 1980 and 2019 was conducted using PubMed, Ovid, MEDLINE, and Cochrane Systematic Review databases. The search identified 18 case reports and 8 retrospective studies. Fracture of the middle part of the catheter may be induced by constant compression of the catheter between the first-rib and clavicle, which is called the pinch-off syndrome. Catheter fracture at the port-catheter junction may be caused by extrinsic compression near the port-catheter junction combined with material fatigue due to repeated bending of the catheter with shoulder movement. There is no specific cause for the fracture of a catheter tip. An annual chest X-ray is recommended for the early detection of TIVAP catheter fracture. Percutaneous endovascular retrieval of a dislodged Port-A catheter is both safe and effective.

Acta Med Iran 2020;57(12):686-689.

Keywords: Totally implantable venous access port; Fracture; Mechanism; Oncology; Pinch off syndrome

Introduction

A totally implantable venous access port (TIVAP) plays a crucial role in the treatment of patients in oncology. It provides a safe means of accessing the vascular system for intravenous delivery of chemotherapeutic drugs and fluids. TIVAP has become an essential prerequisite for many chemotherapy protocols in solid tumors and hematological malignancies (1). TIVAP is a subcutaneously implanted port made of titanium connected to a silicone central venous catheter. It provides a safe means of accessing the vascular system for intravenous delivery of chemotherapeutic drugs and fluids.

Despite being safe, they are not without risk. The most common complication is bacteremia associated with the catheter. Other non-infectious complications such as thrombosis, malfunction, extrusion of the reservoir, and migration of the catheter tip have a much lower incidence (1,2).

We report here a systematic review of the literature about the mechanism of fracture of TIVAP to make physicians aware of this fatal entity.

Materials and Methods

A search of the literature between 1980 and 2019 was conducted using PubMed, Ovid, MEDLINE, and Cochrane Systematic Review databases; key words included 'Totally Implantable Venous Access Port,' 'Fracture,' 'Mechanism,' 'Treatment.' The search identified 18 case reports and 8 retrospective studies.

Data extraction was abstracted by 2 independent reviewers. Each article was scrutinized to determine whether it met the predetermined exclusion criteria. Data were abstracted independently by each reviewer using a standardized data collection form to increase the uniformity of data extraction and to reduce reporting bias. In the case of discrepancy, a consensus decision was made with the help of the senior author. We included case reports or studies, including causes of fracture of TIVAP. The exclusion criteria served as a primary screening procedure for excluding: - Case reports, letters, editorials, comments, reviews, and abstracts with insufficient details, and if the full text was not available.

Results

Corresponding Author: W. Ben Kridis
Department of Medical Oncology, Habib Bourguiba University Hospital, Sfax, Tunisia
Tel: +694492526, Fax: +674241511 E-mail addresses: walabenkridis@yahoo.fr

Fracture of the middle part of the catheter may be induced by constant compression of the catheter between the first-rib and clavicle, which is called the pinch-off syndrome. It was firstly described in 1990 by Hinke *et al.*, (2). Catheter fracture at the port-catheter junction may be caused by extrinsic compression near the port-catheter junction combined with material fatigue due to repeated bending of the catheter with shoulder movement, unlike the pinch-off syndrome. In univariate analysis, the TIVAP implantation method and distance between the port and the clavicle were associated with an increased risk of catheter fracture (3). A sharp angle may lead to increased local pressure and initiate fatigue cracks. TIVAP implantation dates back from more than 200 days (45 months~1350 days) may be the real cause of catheter fracture. In a retrospective study of 34 cases, predictive factors of catheter fracture were implantation method, duration of implantation, the brand of device, and port-clavicle distance (4). Implantation more than 200 days and a port-clavicle distance <2.5 cm were independent factors for fracture of TIVAP on multivariate analysis and were associated with a significantly higher risk of catheter fracture on stratified analysis. Literature reports on TIVAP catheter fracture are analyzed in table 1 (4,5,6, 7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32).

Table 1. Mechanisms of catheter fracture

Author	Number of cases	Mechanism
Rebahi *et al.*, [5]	4	Pinch off syndrome
Nagasawa *et al.*, [6]	1	Materiel failure
Cortés-Flores et al., [7]	156	-
Doley *et al.*, [8]	1	Duration of materiel
Kim *et al.*,[9]	442	-
Shimizu *et al.*, [10]	1	Pinch off syndrome
Nishinari *et al.*, [11]	350	Materiel failure
Lin *et al.*, [12]	3358	-
Wang *et al.*, [13]	1	Pinch off syndrome
Ghayyda *et al.*, [14]	1	-
Chang *et al.*, [15]	1131	Trauma
Kapadia *et al.*, [16]	1	Pinch off syndrome
Gowda et al. [17]	1	-
Schummer et al. [18]	2	-
Denny and Frank1 [19]	1	Pinch off syndrome
Iannelli et al. [20]	1	Trauma
Ferrari *et al.*, [21]	1500	Pinch off syndrome
Kock *et al.*, [22]	2	-
Klotz *et al.*, [23]	1	Pinch off syndrome
Raungaard and Thuesen [24]	1	-
Lorenz *et al.*, [25]	1	-
Chang *et al.*, [4]	34	Pinch off syndrome
Balsorano *et al.*, [26]	65	Type of port
Pignataro *et al.*, [27]	1	excessive mobility of the catheter
Ben Kridis *et al.*, [28]	1	Duration of materiel
Koet *et al.*, [29]	1	Thrombosis
Lukito *et al.*, [30]	1	-
Siajo *et al.*, [31]	3	Type of port
Nas *et al.*, [32]	1	Thrombosis

Discussion

Totally implantable venous access port (TIVAP) was first introduced in the early 1980s. It is now routinely used in oncology, facilitating chemotherapy administration. It offers more advantages than partially implantable systems: low infection rates and unrestricted freedom in patients' physical activities. However, this device is not riskless.

Catheter fracture is a serious complication, with an estimated incidence of 0, 1% - 1% (1). Although the complication rate is low, it can be fatal if the dislodged fragment migrates into the heart, causing arrhythmias or embolization into the pulmonary artery. The causes of a catheter fracture of the TIVAP are unclear but might include the following (6,12). First, degradation and

alteration in the mechanical properties of the catheter material, probably caused by the drugs administered. Second, the flushing of the catheter should be performed gently using a 10 mL syringe to prevent catheter fracture because smaller syringes generate greater pressure, which increases the risk of rupture. Third, chronic stress against the catheter induced by the motion of the neck, clothing with a stiff collar or jewelry, and a safety belt or strap of the backpack, could affect catheter wall structure and cause the catheter fractures. By Balsorano *et al.*, in over 338 removed ports, 12 Groshong catheters out of 65 (18.5%) had evidence of partial rupture of the catheter wall. Amongst considered variables, the "out-of-plane" approach, and type of port (silicon, closed tip with Groshong valve) were the only ones significantly associated with catheter ruptures (*P*=0.0003 and 0.0008, respectively). There was no evidence of rupture in any open-ended silicon catheter (Celsite ports) or in any catheter inserted by the "in-plane" approach to the vein (26). By Vandoni *et al.*, silicon catheters are more resistant to fracture than polyurethane catheters. Also, TIVAP implantation dates back from more than 200 days may be the real cause of catheter fracture (33). Fractures may occur at the connection between the port and the catheter or at the catheter tip. By Lin *et al*., the most common site of fracture was located at the junction between the injection port and the catheter (12). In fact, the compression of the catheter between the clavicle and the first rib in the costoclavicular space also called Pinch off syndrome, may cause fracture of TIVAP.

To prevent the occurrence of catheter fracture of TIVAP, many researchers recommended that the catheter of TIVAP was inserted through the right internal jugular vein (IJV). In fact, by Wu *et al.*, they reported that the implantation via the subclavicular vein route was a significant risk factor for catheter fracture of TIVAP (*P*=0.0001) (34).

Various presentations were described in previous reports, including infraclavicular pain, paraesthesias in the arm, cardiac arrhythmias, palpitation, and resistance to infusion. However, more than 50 % of fractured ports were clinically asymptomatic (28).

Early removal as soon as possible is necessary to prevent distal embolization. Thoracotomy

was the principal technique to remove the fractured fragment. Since the first report by Thomas et al. in 1964, the percutaneous transvenous approach has become the technique of choice to remove intravascular foreign bodies. However, the potential risk of damage to the heart valves and fatal arrhythmias should be kept in mind (35).

There is no specific cause for the fracture of a catheter tip, but it is most likely the result of a combination of two factors: material with potential fatigue associated with excessive movement of a specific point of the catheter secondary to pinch off syndrome or greater mobility. Regarding the material, it has been shown that silicone catheters are more resistant to fracture than polyurethane catheters. An annual chest X-ray is recommended for the early detection of TIVAP catheter fracture. Percutaneous endovascular retrieval of a dislodged Port-A catheter is both safe and effective. However, there are potential risks of valves damage and fatal tachycardia during retrieval of the fractured Port-A catheter.

References

1. Yildizeli B, Lacin T, Baltacioglu F, Batirel HF, Yuksel M. Approach to fragmented central venous catheters. Vascular 2005;13:120-3.
2. Mirza B, Vanek VW, Kupensky DT. Pinch-off syndrome: Case report and collective review of the literature. Am Surg 2004;70:635-44.
3. Chang HM, Hsieh CB, Hsieh HF, Chen TW, Chen CJ, Chan DC, et al. An alternative technique for totally implantable central venous access devices. A retrospective study of 1311 cases. Eur J Surg Oncol 2006;32:90-3.
4. Chang HM, Chou YC, Hsu SD, Liao GS, Chen TW, Hsieh CB, et al. Predictive Risk Factors for Fracture at Catheter of Totally Implantable Venous Access Devices via Subclavian Vein Insertion. J Med Sci 2014;34:161-5.
5. Rebahi H, El Adib AG, Mouaffak Y, El Hattaoui M, Chaara A, Sadek H, et al. Catheter fracture and pulmonary embolization of the distal fragment: A rare complication of the totally implantable venous access port. Rev Med Interne 2015;36:42-6.
6. Nagasawa Y, Shimizu T, Sonoda H, Chou H, Mekata E, Tani T. Is catheter rupture rare after totally implantable access port implantation via the right internal jugular vein. Report of a case. Surg Today 2014;44:1346-9.
7. Cortés-Flores AO, Morgan-Villela G, Juárez-Uzeta EA, Fuentes-Orozco C, Jiménez-Tornero J, González-Ojeda A. Totally implantable central venous access devices in patients with cancer. Experience at a private oncology center. Cir Cir 2012;80:429-34.
8. Doley RP, Brar P, Chaudhary S, Bedi R, Swami AC, Wig JD. Port catheter fracture and migration in Internal Jugular Vein. Am J Case Rep 2012;13:14-6.
9. Kim JT, Oh TY, Chang WH, Jeong YK. Clinical review and analysis of complications of totally implantable venous access devices for chemotherapy. Med Oncol 2012;29:1361-4.
10. Shimizu T, Mekata E, Murata S, Yamamoto T, Tani T. A

case of catheter fracture of a totally implantable access port introduced through the right internal jugular vein. J Surg Oncol 2011;103:460-1.

11. Nishinari K, Wolosker N, Bernardi CV, Yazbek G. Totally implantable ports connected to valved catheters for chemotherapy: Experience from 350 Groshong devices.
J Vasc Access 2010;11:17-22.
12. Lin CH, Wu HS, Chan DC, Hsieh CB, Huang MH, Yu JC. The mechanisms of failure of totally implantable central venous access system: Analysis of 73 cases with fracture of catheter. Eur J Surg Oncol 2010;36:100-3.
13. Wang CS, Yang CY, Chen SC, Chen HC, Huang MS. Hepatic migration of a catheter fragment followed by disconnection of a totally implantable venous access port. Int J Artif Organs 2008;31:1059-61.
14. Ghayyda SN, Roland D, Cade A. Seat belt associated central line fracture: A previously unreported complication in cystic fibrosis. J Cyst Fibros 2008;7:448-9.
15. Chang HM, Hsieh CB, Hsieh HF, Chen TW, Chen CJ, Chan DC, et al. An alternative technique for totally implantable central venous access devices. A retrospective study of 1311 cases. Eur J Surg Oncol 2006;32:90-3.
16. Kapadia S, Parakh R, Grover T, Yadav A. Catheter fracture and cardiac migration of a totally implantable venous device. Indian J Cancer 2005;42:155-7.
17. Gowda MR, Gowda RM, Khan IA, Punukollu G, Chand SP, Bixon R, et al. Positional ventricular tachycardia from a fractured mediport catheter with right ventricular migration: A case report. Angiology 2004;55:557-60.
18. Schummer W, Schummer C, Schelenz C. Case report: The malfunctioning implanted venous access device. Br J Nurs 2003;12:210, 212-4.
19. Denny MA, Frank LR. Ventricular tachycardia secondary to Port-A-Cath fracture and embolization. J Emerg Med 2003;24:29-34.
20. Iannelli A, Kianmanesh R, Msika S, Marano A, Levesque M, Grandjean M, et al. Post-traumatic fracture and migration in the pulmonary artery of the catheter of a totally implantable venous access device. Unusual complication. Minerva Chir 2001;56:303-6.
21. Ferrari A, Nahas S, Maccaferri R, Malacarne P. Pinch-off syndrome and rupture of totally implanted venous access. Report of a case. Recenti Prog Med 2000;91:297-300.
22. Kock HJ, Pietsch M, Krause U, Wilke H, Eigler FW. Implantable vascular access systems: Experience in 1500 patients with totally implanted central venous port systems. World J Surg 1998;22:12-6.
23. Klotz HP, Schöpke W, Kohler A, Pestalozzi B, Largiadèr F. Catheter fracture: A rare complication of totally implantable subclavian venous access devices. J Surg Oncol 1996; 62:222-5.
24. Raungaard B, Thuesen L. Percutaneous removal of an in-situ embolised catheter fragment in a patient with Port-A-Cath. Ugeskr Laeger 1995;157:7152-3.
25. Lorenz M, Hottenrott C, Seufert RM, Encke A. A totally implantable permanent central venous access, longterm experience with subcutaneous infusion chambers. Langenbecks Arch Chir 1988;373:302-9.
26. Balsorano P, Galducci G, De Fanti I, Evans SK, De Gaudio AR, Pelagatti C. Fractures of totally implantable central venous ports: more than fortuity. A three-year single center experience. J Vasc Access. 2014, 391-5.
27. Pignataro BS, Nishinari K, Wolosker N, Bomfim GA. Fracture and migration into the coronary sinus of a totally implantable catheter introduced via the right internal jugular vein. BMJ Case Rep 2014;2014:207276.
28. Ben Kridis W, Sahnoun M, Maraoui H, Amari N, Frikha M. Fracture at catheter of totally implantable venous access port with migration into the right pulmonary artery: A serious complication. Acta Clin Belg 2016;13:1-4.
29. Ko SY, Park SC, Hwang JK, Kim SD. Spontaneous fracture and migration of catheter of a totally implantable venous access port via internal jugular vein a case report. J Cardiothorac Surg. 2016 11;11:50.
30. Lukito A, Pranata R, Huang I, Thengker A, Wirawan M. Fracture of the Port Catheter and Migration Into the Coronary Sinus: Case Report and Brief Review of the Literature Clin Med Insights Case Rep 2019;12:1179547619832282.
31. Saijo F, Mutoh M, Tokumine J, Yoshinobu O, Hama H, Namima T et al. Late fracture of Groshong ports: A report of the three cases. J Vasc Access 2019;20:563-6.
32. Nas H, Bowe D, Soubani AO. An unusual complication after placement of an inferior vena cava filter via right internal jugular vein access. J Vasc Access 2019;20:102-4.
33. Vandoni RE, Guerra A, Sanna P, et al. Randomised comparison of complications from three different permanent central venous access systems. Swiss Med Wkly 2009;139:313-6.
34. Wu CY, Fu JY, Feng PH, Kao TC, Yu SY, Li HJ, et al. Catheter fracture of intravenous ports and its management. World J Surg 2011;35:2403-10.
35. Gabelmann A, Kramer S, Gorich J. Percutaneous retrieval of lost or misplaced intravascular objects. Am J Roentgenol 2001;176:1509-13.