

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

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**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.

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**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

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

## Fracture at catheter of totally implantable venous access port

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.

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