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Complications associated with the removal of totally implantable venous access devices (TIVADs): a retrospective analysis of 4,954 breast cancer patients in a single institution

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Abstract

Background Totally implantable venous access devices (TIVADs) have been widely used for many years in the management of cancer patients. However, previous studies have rarely focused on the period surrounding TIVAD removal, which is a critically important phase for these devices. This study aims to address this gap by investigating the surgical approaches, timing, and associated complications related to the removal of TIVADs, thereby enhancing the management of these devices.

Method A retrospective analysis was conducted on a cohort of 4,954 TIVAD extraction procedures performed at the Breast Center of the Fourth Hospital of Hebei Medical University between January 1, 2016, and August 1, 2023.

Results Among 4,954 cases, the indwelling time of TIVADs for included patients ranged from 2 to 60 months. 4,882(98.5%) cases removed their TIVADs after completion of cancer treatment, while 72 cases (1.5%) were unplanned removal due to TIVADs related complications. Two surgical techniques were observed for port removal: in 20% of cases, the injection port was removed first, followed by the catheter; in 80% of cases, the catheter was removed first, followed by the injection port. Complications during TIVADs removal were observed in 13 cases (0.3%) including 2 cases of bleeding, 5 cases difficulty in removal of the port and catheter, and 6 cases representing of delayed wound healing. Longer indwelling time tended to have higher risk of developing catheter rupture and fracture.

Conclusion This study provides valuable insights into the removal of TIVADs in cancer patients. Complications during removal were uncommon but included bleeding, difficulty in removing the port and catheter, and delayed wound healing. Additionally, longer indwelling times were associated with an increased risk of catheter rupture and fracture, highlighting the need for careful monitoring and timely removal of TIVADs to minimize potential complications. The findings of the study underscore the importance of optimizing TIVAD management, particularly during the removal phase, to improve patient outcomes.

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Keywords Totally implantable venous access devices, Complications, Breast cancer, Difficulty in removal, Thrombus

Background

Totally implantable venous access devices (TIVADs), also known as venous ports, represent a central venous infusion device implanted beneath the subcutaneous tissue for long-term use. TIVDAs were consisted with an injection port and a catheter. TIVADs are favored for their safety, efficacy, and cosmetic advantages. They find extensive application in oncology patients and those requiring prolonged intravenous nutritional support [1]. Insertion and removal of TIVADs demand the expertise of trained medical professionals and entail a slightly higher degree of complexity compared to other central venous access methods. Existing research on TIVADs has primarily concentrated on their implantation and catheter-related complications, with limited attention given to the removal process. To contribute valuable insights to clinical practice and gain a deeper understanding of surgical techniques, complications, and the optimal duration of TIVAD indwelling, we conducted a retrospective analysis encompassing 4,954 cases of TIVADs performed at our department between January 2016 and December 2022.

Methods

Study population

A retrospective observational study was conducted at the Fourth Hospital of Hebei Medical University, focusing on the implantation and removal of TIVADs. The study included a consecutive series of cancer patients who had TIVADs implanted and removed at the hospital between January 1, 2016, and August 1, 2023. Patients' general information, TIVAD indwelling times, and complications were extracted from nursing records and TIVAD maintenance manual.

Methods of TIVADs removal

The patient is placed in a supine position. The area is disinfected and covered with a sterile drape. Local infiltration anesthesia is administered with 1% lidocaine. An incision is made along the original surgical scar to expose the injection port, catheter lock, and part of the catheter. The fibrous capsule tissue surrounding the injection port is incised and separated to fully expose and free the injection port. The catheter is then slowly removed from the vein and subcutaneous tunnel, along with the entire PORT device. Alternatively, the fibrous capsule tissue around the catheter lock and catheter can be incised first, and the catheter is removed from the vein and subcutaneous tunnel before freeing and removing the injection port. During the procedure, care should be taken to protect the catheter when incising the skin above the port and separating the fibrous capsule tissue around the catheter lock and catheter. This should be done slowly and carefully to avoid violent separation. The fingers of the left hand can be used to press the catheter at the clavicle [2] to prevent catheter damage and potential catheter fracture leading to its entry into the right atrium. After the PORT is removed, check if the device is intact. The subcutaneous tunnel opening is sutured in a figure-eight pattern, and the venipuncture site is compressed for 5 min [3] to prevent blood reflux from the internal jugular vein into the pocket, which could cause a surrounding hematoma and air embolism. Finally, remove the fibrous capsule tissue around the injection port, ensure meticulous hemostasis, suture the subcutaneous tissue and skin, and cover the surgical incision with a sterile dressing. The two surgical methods are illustrated below (Figs. 1 and 2).

Detecting complications

TIVAD-related infections, including localized tissue infections and bloodstream infections, were identified based on signs and symptoms documented in nursing records or positive blood culture results. The integrity of the catheter was assessed by the surgeons upon TIVAD removal, and any observed catheter disruption or fractures were also recorded in the nursing records. Thrombosis was confirmed by ultrasound or angiography.

Results

General information of included patients

A total of 4,954 patients were included in our study. Of these, 4,911 were diagnosed with breast cancer, 35 with lymphoma, six with gastrointestinal tumors, and two with gynecological tumors. The average age of the patients was 50.5±10.65 years. All patients underwent TIVAD implantation by qualified surgeons via the internal jugular vein, with the injection ports positioned on the chest wall. Specifically, 2,912 patients received silicone Groshong-type catheters, while 2,042 were fitted with polyurethane catheters featuring an open-end design. Among the 4,954 TIVAD procedures, the technique of removing the injection port first, followed by the catheter, was employed in 991 cases (20%). In the remaining 3,963 cases (80%), the catheter was removed first, followed by the injection port. Of the total cases, 4,882 (98.5%) involved planned port removal after the completion of treatment, while 72 cases (1.5%) required unplanned port removal due to complications (See Table 1 for detailed reasons for TIVADs removal).

Complications during port removal

In the study, complications were recorded in 13 cases (0.3%). Three patients had their injection ports removed

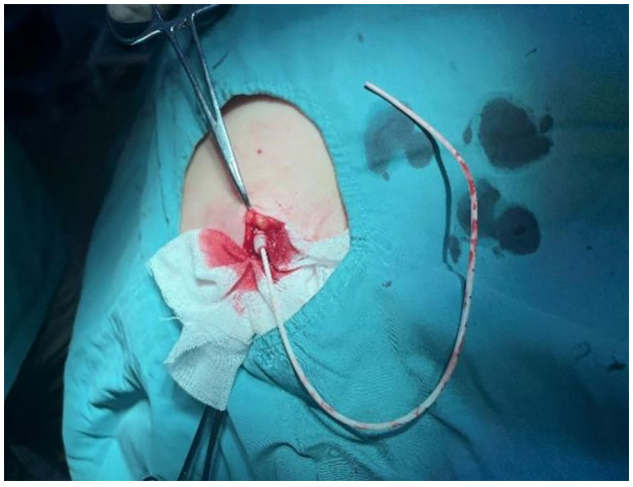

Fig. 1 Catheter-first removal method

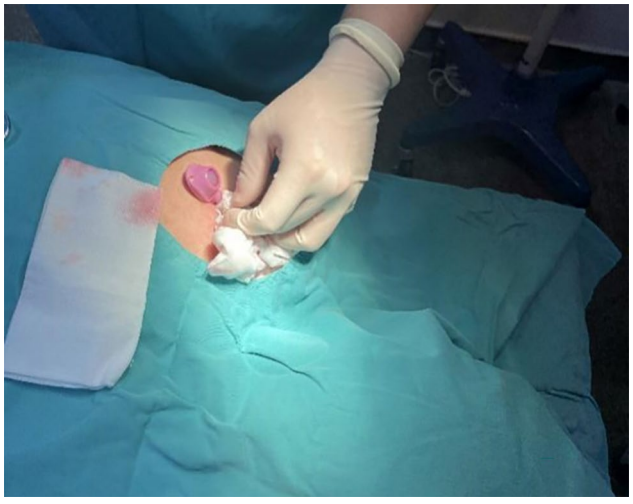

Fig. 2 Port-first removal method

Table 1 Reasons for removal of TIVADs (*N* = 4,954)

Reasons for Removal	Cases (%)	Indwelling Time (Mean ± SD or Median [IQR])
Off-treatment	4882 (98.5)	210 ± 30 days
TIVAD Infection	5 (0.1)	120 ± 30 days
Rejection reaction	18 (0.4)	165 ± 38.73 days
Injection port infection	10 (0.2)	120 ± 47.43 days
Catheter rupture	25 (0.5)	1095 ± 577.12 days
Catheter fracture	10 (0.2)	1740 ± 917.06 days
Catheter blockage	2 (0.04)	105 ± 21.21 days
Catheter displacement	2 (0.04)	120 ± 30 days

but left the catheters in place due to thrombosis [4]. Two patients were hospitalized due to difficulty in catheter removal. Two cases presented with hematomas. Delayed wound healing was observed in six cases. Post-removal examination revealed 25 cases of catheter fractures and 10 cases of catheter disruptions. All instances of fractures or disruptions involved silicone catheters.

Table 2 Description of TIVAD removal-related complications

Complications	Cases	Indwelling time(months or mean ± SD)
Unable to remove	3	29 months, 57 months, 60 months
Difficulty in removal	2	5 months, 8 months
Hematoma	2	6 months, 8 months
Delayed wound healing	6	2–6 months
Catheter fracture	25	1095 ± 577.12 days
Catheter disruption	10	1740 ± 917.06 days

The study further examined the relationship between complications and indwelling times (Table 2). In the three cases where catheter removal was unsuccessful, the TIVADs had been in place for 29 months, 57 months, and 60 months, respectively, indicating significantly prolonged indwelling durations compared to those associated with other complications. Notably, patients who experienced catheter failure had considerably longer indwelling times. Moreover, all 25 cases of catheter fractures or disruptions occurred within indwelling periods ranging from 1 to 5 years, with 17 cases (68%) involving catheters that had been in place for more than 2 years. Additionally, the 10 cases of catheter fractures were exclusively associated with silicone-based venous ports, with indwelling times ranging from 1 year and 7 months to 8 years; of these, 8 cases (80%) involved indwelling times exceeding 2 years.

Discussion

The removal of TIVADs is a critical aspect of patient care, particularly for those undergoing long-term treatment for conditions such as breast cancer. Our study analyzed 4,954 cases of TIVADs removal, providing important insights into the complications associated with this procedure and offering recommendations for best practices. Our findings indicate that the overall complication rate is relatively low, at 0.3%, consistent with previous literature. This supports the general safety and efficacy of TIVAD removal when performed by experienced clinicians. However, we observed specific complications that warrant attention, including pocket bleeding, delayed wound healing, and difficulties in catheter removal. Notably, three cases involved an inability to remove the catheter, which were associated with significantly prolonged indwelling times of 29, 57, and 60 months, respectively. This finding aligns with previous research suggesting that longer indwelling times increase the risk of complications such as catheter adhesion and thrombosis. One of the most significant findings of our study is the high incidence (61.3%) of internal jugular vein thrombosis among patients with polyurethane catheters. The three cases where catheter removal was unsuccessful were all

associated with chronic thrombosis and severe adhesion to the catheter at the internal jugular or brachiocephalic veins. Consequently, we performed neck vascular ultrasound screening in a group of 31 patients scheduled for TIVAD removal, identifying internal jugular thrombosis in 19 patients, resulting in an incidence rate of 61.3%. The duration of port implantation in these 19 patients ranged from 9 months to 2.5 years, and all ports were made of polyurethane. This rate is significantly higher than the 2–26% [5] range reported in other studies, underscoring the necessity of routine neck ultrasound examinations for all patients with venous ports to detect asymptomatic thrombosis early. This proactive approach could mitigate serious complications such as thrombus dislodgement or catheter fracture during removal. Our data suggest that routine neck vascular ultrasound screening prior to TIVAD removal may be a valuable preventive measure. However, the 61.3% incidence of internal jugular thrombosis reported in our study is based on a limited patient population, and the data have limitations. There is currently a lack of related studies to guide this practice, and further research is needed to determine whether routine evaluation with neck ultrasound should be recommended before port removal. For patients found to have deep vein thrombosis, we recommend delaying catheter removal until after a period of anticoagulation therapy, which may help stabilize the thrombus and facilitate successful catheter removal. Avoiding catheter removal during the acute phase of thrombosis is a simple and effective measure to reduce the risk of pulmonary embolism caused by thrombus dislodgement [6].

In our previous experience, we encountered 23 cases where silicone catheters exhibited chronic fractures upon removal (Fig. 3). If not handled carefully during surgery, these fractured catheters could break off into the circulatory system, necessitating interventional surgery to retrieve the free-floating catheter segments. Therefore, we emphasize the need for extra caution when removing silicone-based venous ports to avoid excessive manipulation that could lead to catheter fracture. We believe that removing the catheter first, followed by the port, is a safer approach.

We also noted that while silicone catheters are widely used, they are prone to rupture [7], especially after prolonged indwelling periods. This observation is consistent with the findings of Li Li et al. [8], who also reported a higher incidence of catheter rupture with long-term use. Moreover, prolonged catheter indwelling increases the likelihood of damaging the vascular endothelium, leading to phlebitis and potentially inducing thrombosis. If thrombosis adheres to the catheter, removal can become challenging, as seen in the three cases where catheter removal was impossible, all of which involved indwelling

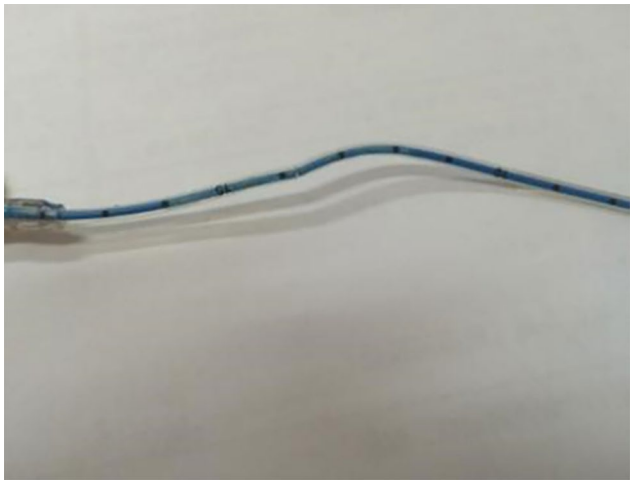

Fig. 3 Catheter fracture after port removal
The fracture of the catheter is one main reason for unplanned TIVADs removal, with most ruptures occurring in the ministry of turnback of the catheter

times of more than 2 years. Therefore, we recommend limiting the indwelling time to less than 2 years.

In summary, the following points should be considered when removing a venous port: (1) Provide detailed information and obtain informed consent before the procedure. (2) Conduct a comprehensive pre-removal evaluation, and inform the patient and family of any abnormalities, proceeding with caution. (3) Perform the procedure gently and meticulously to prevent complications such as catheter fracture. (4) Inspect the catheter for integrity after removal. (5) If difficulties arise during catheter removal, consider a multidisciplinary discussion to analyze the cause and develop a reasonable solution. Venous ports should be promptly removed once they are no longer needed for patient treatment. Comprehensive pre-removal evaluation and strict adherence to procedural protocols can effectively prevent complications.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12893-024-02630-w.

Supplementary Material 1

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Author contributions
All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval and consent to participate
This study was conducted with the approval of the ethics committee of Hebei Medical University Fourth Affiliated Hospital (2021KY248). Since this retrospective study analyzed the medical records obtained in the past clinical diagnosis and treatment, the Ethics Committee of Hebei Medical University Fourth Affiliated Hospital agreed to waive the patient's written informed consent. The study was performed in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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