

Complications of imaging-assisted port catheters and factors affecting complications

Görüntüleme eşliğinde takılan port kateterlerinin komplikasyonları ve komplikasyonlara etki eden faktörler

Muhammed Tekinhatun, Muhammet Arslan, Halil Serdar Aslan, Hüseyin Gökhan Yavaş
Mahmut Demirci, Başak Ünver Koluman, Kadirhan Alver

Posted date:30.09.2023

Acceptance date:13.02.2024

Abstract

Purpose: This research investigates complications associated with Imaging-Assisted Port Catheters (IAPCs) to provide insights for healthcare professionals involved in their usage. The study aims to optimize patient safety, implement preventive strategies, and guide evidence-based decision-making in the clinical use of IAPCs.

Materials and methods: A retrospective study comprising 1247 patients who underwent IAPC placement in the Interventional Radiology Unit between 01.09.2012-01.09.2020 was conducted. Data, including indications for port placement, complications, duration of port stay, and reasons for explantation, were extracted from electronic medical records. Comparative analysis with surgically implanted ports was performed, and the efficacy and safety of imaging-guided port implantation were assessed.

Results: The study predominantly involved right internal jugular vein placement (93.8%). Major complications did not occur during the 7 to 1330 days of port usage. The average usage period was 243 days, totaling 310,503 catheter-days. Infectious complications were the most common (4.8%), significantly higher (13.9%) in hematological malignancies. Multivariate analysis revealed a significantly increased complication rate in hematological malignancy patients ($p<0.001$).

Conclusion: The research reveals an 8.6% overall incidence of complications in IAPC usage, with hematologic malignancy identified as a significant independent risk factor. The low complication rate per 1000 catheter days (0.36) aligns with recent studies, emphasizing the benefits of image guidance and procedural expertise. Notably, infectious complications, especially in hematologic malignancy patients, underscore the need for further research to refine IAPC management for long-term intravenous access. The study contributes essential insights for healthcare professionals involved in the field, emphasizing ongoing efforts in advancing IAPC management for the benefit of patients.

Keywords: Cancer treatment, catheterization, complication, totally implantable access port, ultrasound guidance.

Tekinhatun M, Arslan M, Aslan HS, Yavas HG, Demirci M, Unver Koluman B, Alver K. Complications of imaging-assisted port catheters and factors affecting complications. Pam Med J 2024;17:303-312.

Öz

Amaç: Bu araştırma, Görüntüleme Destekli Port Kateterler (IAPC'ler) ile ilişkili komplikasyonları araştırarak, bunların kullanımında yer alan sağlık çalışanlarına öngörü sağlamaktadır. Çalışma, hasta güvenliğini optimize etmeyi, önleyici stratejiler uygulamayı ve IAPC'lerin klinik kullanımında kanıta dayalı karar verme sürecine rehberlik etmeyi amaçlamaktadır.

Gereç ve yöntem: Girişimsel Radyoloji Ünitesinde 01.09.2012-01.09.2020 tarihleri arasında IAPC yerleştirilen 1247 hastayı içeren retrospektif bir çalışma yapıldı. Port yerleştirme endikasyonları, komplikasyonlar, portun kalış süresi ve eksplantasyon nedenleri dahil olmak üzere veriler elektronik tıbbi kayıtlardan elde edildi. Cerrahi olarak implante edilen portlarla karşılaştırmalı analiz yapıldı ve görüntüleme kılavuzluğunda port implantasyonunun etkinliği ve güvenliği değerlendirildi.

Muhammed Tekinhatun, Asst. Prof. Dicle University, Department of Radiology, Diyarbakir, Türkiye, e-mail: mtekinhatun@gmail.com (<https://orcid.org/0000-0002-3240-6991>) (Corresponding Author)

Muhammet Arslan, Assoc. Prof. Pamukkale University, Department of Radiology, Denizli, Türkiye, e-mail: dr.marslan@hotmail.com (<https://orcid.org/0000-0001-5565-0770>)

Halil Serdar Aslan, Asst. Prof. Pamukkale University, Department of Radiology, Denizli, Türkiye, e-mail: draslan@outlook.com (<https://orcid.org/0000-0002-5255-8618>)

Hüseyin Gökhan Yavaş, Asst. Prof. Dumlupınar University, Department of Radiology, Kütahya, Türkiye, e-mail: huseyingokhanyavas@gmail.com (<https://orcid.org/0000-0003-4220-3482>)

Mahmut Demirci, M.D. Denizli State Hospital, Department of Radiology, Denizli, Türkiye, e-mail: dr.mahmutdemirci@gmail.com (<https://orcid.org/0000-0001-8201-9618>)

Başak Ünver Koluman, Asst. Prof. Pamukkale University, Department of Hematology, Denizli, Türkiye, e-mail: basakunver@yahoo.com (<https://orcid.org/0000-0003-1106-5021>)

Kadirhan Alver, M.D. Denizli State Hospital, Department of Radiology, Denizli, Türkiye, e-mail: kadirhanalver@gmail.com (<https://orcid.org/0000-0002-4692-2401>)

Bulgular: Çalışmada ağırlıklı olarak sağ internal juguler ven yerleştirildi (%93,8). Portun 7 ila 1330 günlük kullanımı sırasında majör komplikasyon görülmedi. Ortalama kullanım süresi 243 gün ve toplam 310.503 kateter günü idi. En sık enfeksiyöz komplikasyonlar (%4,8) görülmüş olup hematolojik malignitelerde anlamlı derecede yüksektir (%13,9). Çok değişkenli analiz hematolojik malignite hastalarında komplikasyon oranının önemli ölçüde arttığını ortaya koymuştur ($p<0,001$).

Sonuç: Araştırma, IAPC kullanımında genel komplikasyon insidansının %8,6 olduğunu ve hematolojik malignitenin önemli bir bağımsız risk faktörü olarak tanımlandığını ortaya koymaktadır. Her 1000 kateter günü başına düşen düşük komplikasyon oranı (0,36), görüntü rehberliği ve prosedürel uzmanlığın faydalarını vurgulayan son çalışmalarla uyumludur. Özellikle hematolojik malignite hastalarında görülen enfeksiyöz komplikasyonlar, uzun süreli intravenöz erişim için IAPC yönetimini iyileştirmeye yönelik daha fazla araştırma yapılması gerektiğinin altını çizmektedir. Bu çalışma, hastaların yararına IAPC yönetimini ilerletmek için devam eden çabaları vurgulayarak, bu alanda çalışan sağlık profesyonelleri için önemli bilgiler sunmaktadır.

Anahtar kelimeler: Kanser tedavisi, kateterizasyon, komplikasyon, tamamen implante edilebilir port kateter, ultrason rehberliği.

Tekinhatun M, Arslan M, Aslan HS, Yavaş HG, Demirci M, Ünver Koluman B, Alver K. Görüntüleme eşliğinde takılan port kateterlerinin komplikasyonları ve komplikasyonlara etki eden faktörler. Pam Tıp Derg 2024;17:303-312.

Introduction

The use of subcutaneously placed imaging-assisted port catheters (IAPCs) has become increasingly common. They are preferred especially in patients receiving intermittent and long-term infusion therapy because of the patient comfort they provide and low infection rates [1]. The most common indication for port catheter is patients with malignancy requiring long-term chemotherapy [2]. In the past, venous port catheters were implanted in the operating room under general anesthesia by surgical departments. Venous port insertion in the angiography room with interventional radiology techniques was first described by Morris et al. [3] in 1992, and since then, radiological venous port insertion has been among the routine procedures of interventional radiology.

In adult patients, the port can be placed easily with local anesthesia. Existing radiological images should be examined before port placement, and the planned vein should be evaluated in detail with ultrasound (US). In order to reduce the risk of infection, the area where the port will be placed should be prepared and covered in a sterile manner. The procedure should be done under sterile conditions.

Central venous access complications are now seen rarely in imaging-guided interventions, however, complications can be seen due to the inadequate experience of the practitioner, the difficulty of venous anatomy, and the anatomical-morphological structure of the patient. The occurrence of IAPC-related complications can be influenced by a variety of factors. Patient-related

factors, such as age, underlying comorbidities, immunosuppression, and nutritional status may impact the susceptibility to infections and the overall healing process. Procedural factors, including catheter insertion technique, catheter tip position, and the experience of the healthcare professional performing the procedure can influence the immediate and long-term success of IAPCs. Moreover, device-related factors, such as catheter material, design, and the use of antithrombotic coatings may play a significant role in determining the occurrence of complications. Understanding the spectrum of IAPC-related complications and their determinants is essential for optimizing patient safety, implementing preventive strategies, and guiding evidence-based decision-making in the clinical use of IAPCs. This research aims to provide valuable insights to interventional radiologists, nurses, and other health professionals by understanding IAPCs' factors affecting complications.

Material and methods

Study design

This article is a retrospective study aiming to investigate the factors affecting complications of IAPCs. Ethical approval was obtained from the Institutional Review Board before the commencement of the study. Patients who underwent IAPC placement in our Interventional Radiology Unit between 01.09.2012-01.09.2020 were included in our study. Indications for port placement, early or late complications seen at the venous access and port placement site, duration of port stay, and reasons for explantation were

reviewed from electronic medical records. The results obtained were compared with the data of surgically implanted ports in the literature and the efficacy and safety of imaging-guided port implantation were evaluated.

IAPC placement procedure

All implantation procedures were performed under the guidance of US and angiography device. Implantations were performed under local anesthesia. During the procedure, the requirements of surgical sterility were absolutely fulfilled. Patients with high risk and/or absolute neutropenia (WBC <500/mm³) were given antibiotic prophylaxis with 1 g IV

cefazolin sodium (Sefazol®, Mustafa Nevzat İlaç Sanayi AŞ, İstanbul, Türkiye) 30 minutes before the procedure. Patients who were not hospitalized were followed up for 4-6 hours and sent home. A procedure note including the follow-up procedure was written for the hospitalized patients, and then they were followed up in the service and discharged under appropriate conditions. All patients were called for control one week after the procedure, and it was checked whether there was redness, swelling, temperature increase, hematoma, and separation at the suture site in the port-inserted area. The images of the process steps are given in Figure 1 as a summary.

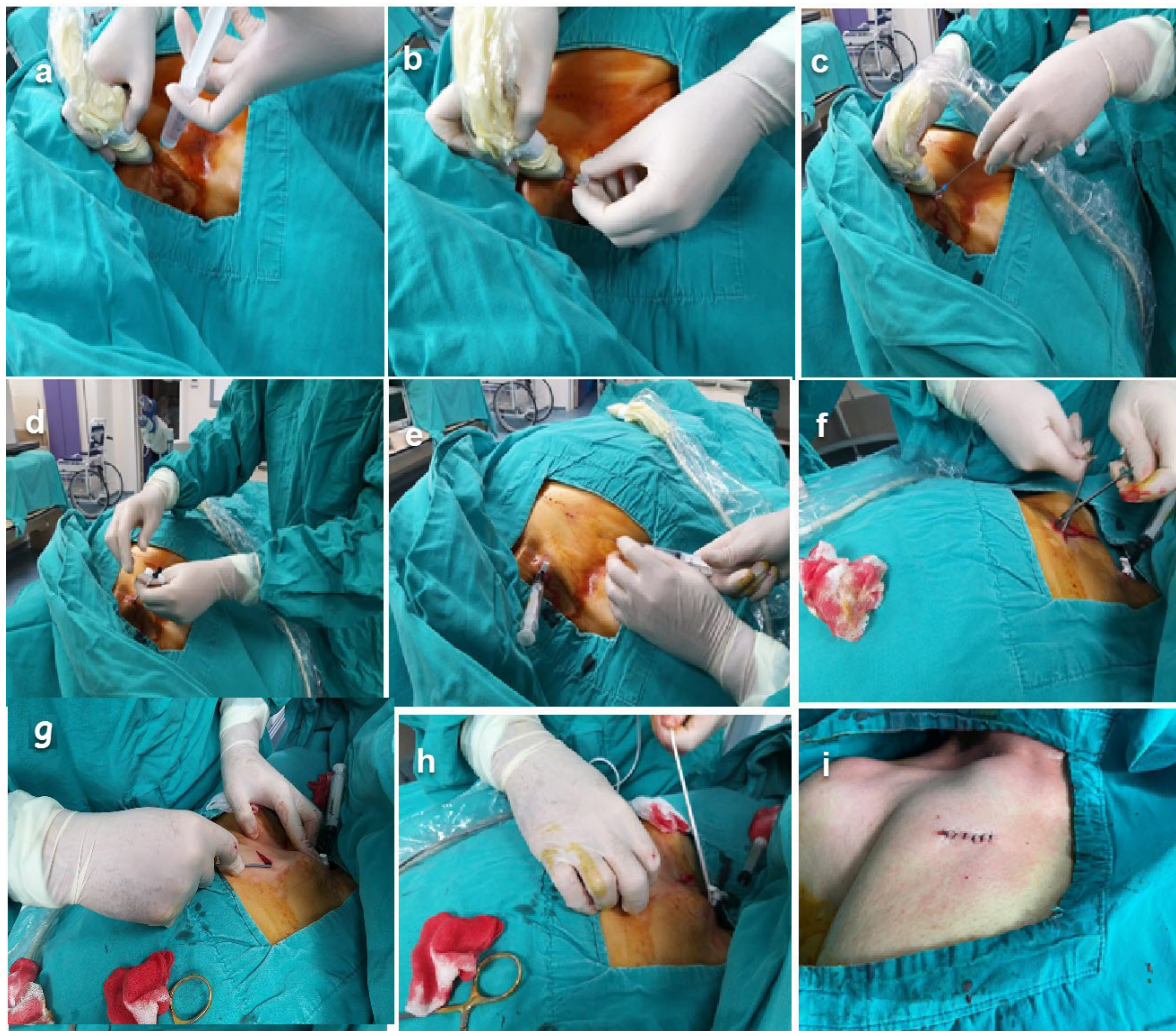


Figure 1. Imaging-assisted port catheter placement steps: a-b) After providing the necessary asepsis conditions, local anesthesia application under ultrasound guidance and needle entry into the vein, c) Insertion of the guide wire through the needle, d) Placement of the peel away sheet over the guide wire, e) Local anesthesia application in the port pocket, f) Opening the port pocket, g) Opening the tunnel with a tunneler, h) Passing the catheter through the tunnel, i) Closing the port pocket with a suture

Complication assessment

Complications were identified from medical records, physician notes, nursing records, and radiological reports. Complications of central venous access were classified into two main groups as early complications (bleeding, haematoma development, catheter malposition, venous perforation, infection, arterial puncture, pneumothorax and air embolism) occurring between catheter placement and first use (<30 days) and late complications (infections, thrombotic and mechanical complications) occurring later (>30 days) (Table 1) [4].

Statistical analysis

Descriptive statistics were used to summarize patient demographics and clinical characteristics. Univariate and multivariate analyses were performed to identify factors associated with the occurrence of IAPC-related complications. Multivariate logistic regression analysis was employed to assess the independent effect of each potential factor on the occurrence of complications, adjusting for confounding variables.

Results

A total of 1247 patients with imaging-guided ports were included in our study. Demographic information, diagnoses and reasons for port catheterization of our patients are given in Table 2. In our patients, it was observed that the right internal jugular vein was most preferred for port catheter placement (93.8%).

There were no major complications such as hemothorax, pneumothorax, arterial injury and nerve injury during port catheter placement. When the data were collected, the port usage

period ranged from 7 to 1330 days, the average usage period was 243 days, and the total usage period was 310,503 catheter-days when all ports were taken into account. During follow-up, 213 patients died while their current port was functional. Also, 139 ports were removed for various reasons. The reasons for port removal in these patients are shown in Table 3. Of all complications, 37 were early (<30 days), 70 were late complications (>30 days). Early and late complications, incidence of complications according to 1000-day port catheter stay, and number of ports removed due to complications are shown in Table 4. Infectious complications were the most common complications, with a rate of 4.8% in all patients, while the incidence was significantly higher in hematological malignancies (13.9%). Figure 2 shows examples of venous thrombosis, catheter fracture, catheter misposition, and catheter pinc-off. Figure 3 shows pictures of malposed port catheters in different patients.

Factors affecting the occurrence of complications were assessed through multivariate logistic regression analysis. The complication rate was statistically significantly higher in patients with hematological malignancies ($p<0.001$). 21 of 62 patients (33.8%) with port infection had hematological malignancy. There was no significant increase in the incidence of complications related to IAPCs in those with head and neck malignancy ($p=0.614$), breast malignancy ($p=0.366$) and those without malignancy ($p=0.259$). In addition, age ($p=0.705$), gender ($p=0.648$), insertion of the catheter in the right or left jugular vein ($p=0.129$) were found to have no statistical significance on the occurrence of complications.

Table 1. Complications after port implantation

Early complications (<30 days)	Late Complications (>30days)
Malposition: intravenous, cardiac	Infection
Arrhythmia	Venous thrombosis, pulmonary embolism
Perforation and bleeding: hemothorax, mediastinal, cardiac tamponade	Venous stenosis
Arterial malpositioning	Catheter pinch-off, fracture and migration
Pneumothorax	Catheter embolization
Thoracic duct injury	Air embolism
Air embolism	

Table 2. The demographic data of the patients and the data regarding the catheters placed

Age (Years) Mean ± SD	59±13 (range 19-95)
Sex (male/female)	
Male	685 (54.9%)
Female	562 (45.1%)
Background disease	
Non-malignant	10 (1%)
Malignant	1237 (99%)
Gastrointestinal malignancies	605
Hematologic malignancies	151
Breast carcinoma	144
Genitourinary system malignancies	94
Head and neck cancer	112
Lung cancer	104
Others	27
Implantation side	
Right	1170
Left	77
Purpose of TIVAP	
Chemotherapy	1214
Nutritional supplementation	25
Both	8

TIVAP, totally implantable vascular access system

Table 3. Results of 1247 port implantations

Duration of catheter stay	For all patients	310503 (catheter-days)
	For a single patient	248 (mean catheter-days)
		7-1330 (range catheter-days)
Follow up	Still in use	895 catheters
	Exitus	213 catheters
	Removal before the end of therapy	82 catheters
	Removal after the end of therapy	57 catheters

Table 4. Complications after port catheter placement

Complication	Patients	Early complications (<30 days)	Late complication (>30 days)	Incidence (%)	Per 1000 catheter days	Port removal
Malposition: intravenous, cardiac	14	10	4	1.12	0.05	6
Arrhythmia	4	4	0	0.32	0.013	0
Perforation and bleeding: hemothorax, mediastinal, cardiac tamponade	0	0	0	0	0	0
Pneumothorax	0	0	0	0	0	0
Thoracic duct injury	0	0	0	0	0	0
Air embolism	0	0	0	0	0	0
Infection	62	8	54	4.97	0.21	59
Venous thrombosis	10	4	6	0.8	0.02	6
Catheter pinch-off, fracture and migration	8	4	4	0.64	0.026	8
Catheter thrombosis	4	2	2	0.32	0.013	1
Hemorrhage, hematoma	3	3	0	0.24	0.01	0
Wound dehiscence	2	2	0	0.16	0.006	2
Total	107	37	70	8.6	0.36	82

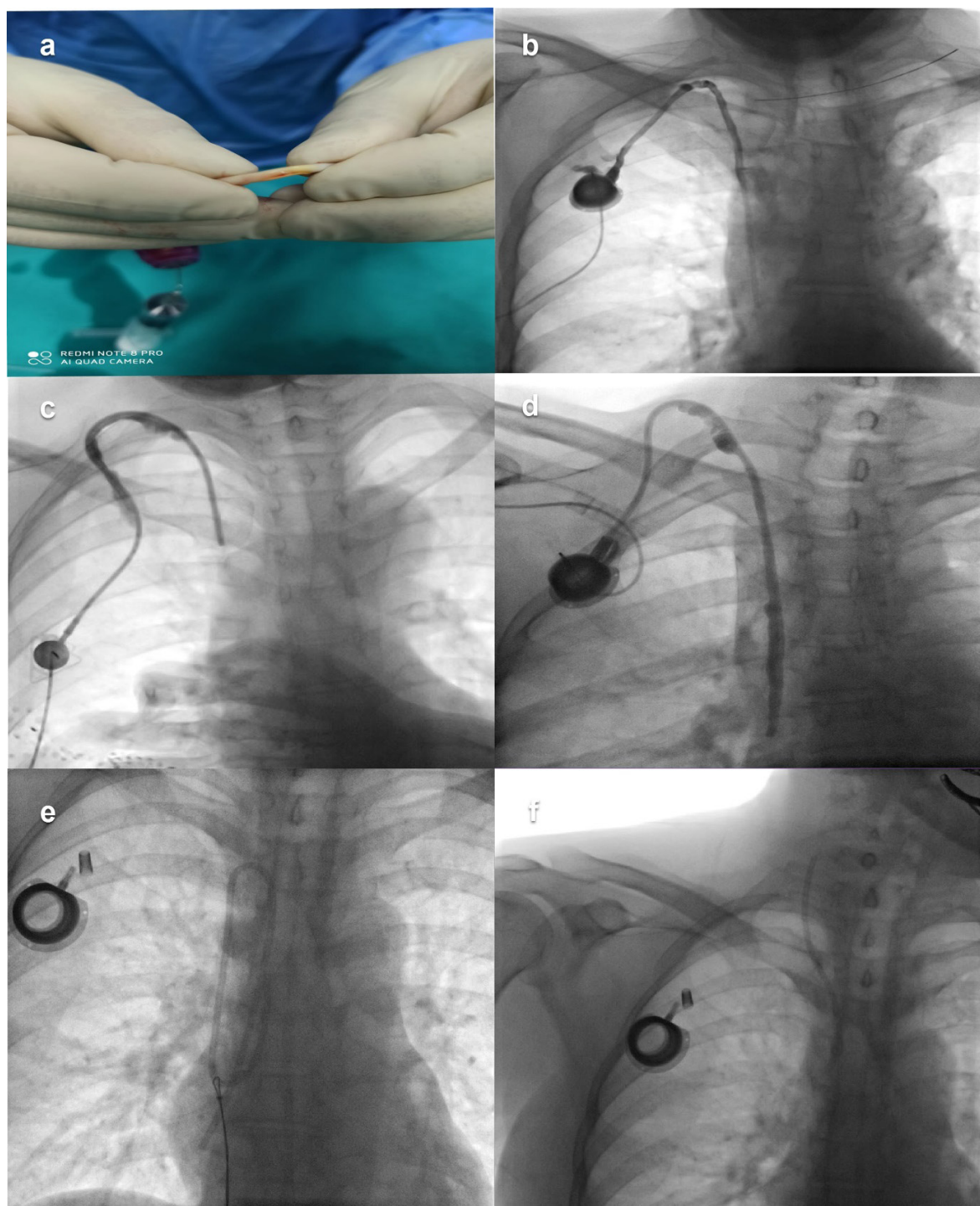


Figure 2. a) Port catheter line fracture, b-d) port catheter thrombosis, e and f) The port catheter line has been separated from the reservoir and has migrated
The port catheter line was removed by catching it with a snare catheter

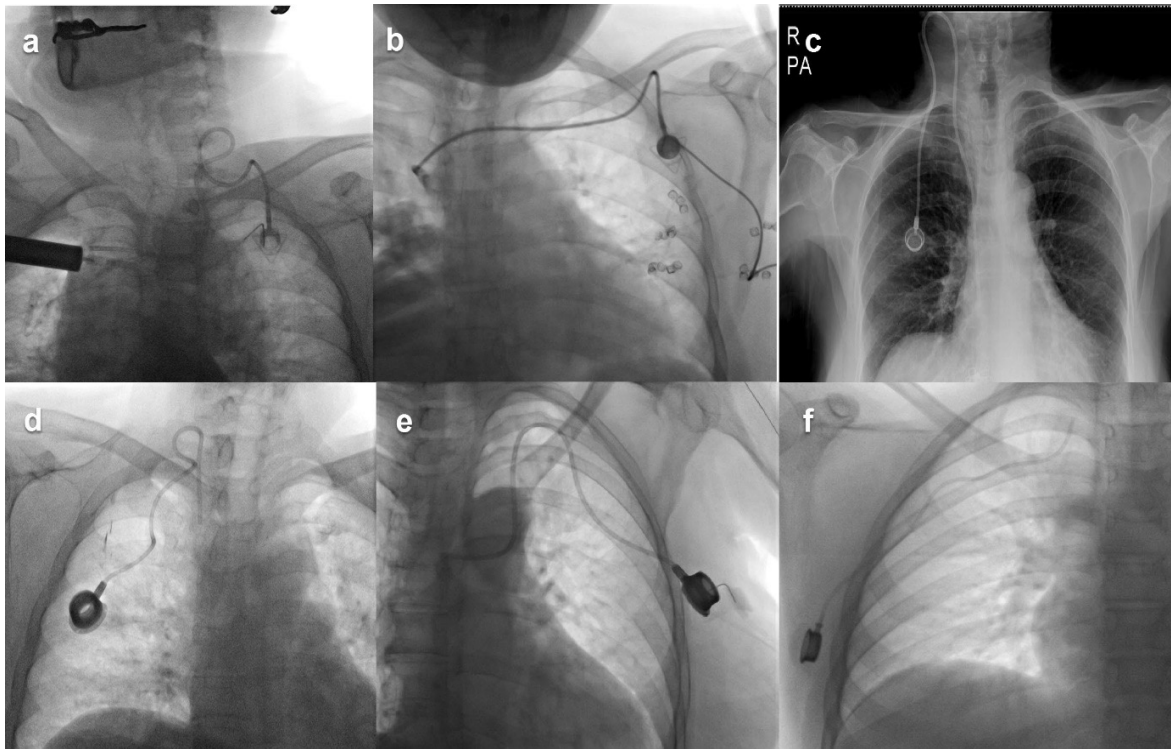


Figure 3. a-f) Pictures of malpositioned port catheters in different patients

Discussion

The present study, exploring the complications associated with IAPCs and their impact on patient outcomes, revealed an overall incidence of 8.6% complications, emphasizing the crucial role of underlying hematologic malignancy as an independent risk factor. The study further highlighted a low complication rate of 0.36 per 1000 catheter days, consistent with recent studies, attributable to the increasing use of image guidance and enhanced procedural expertise. Notably, infectious complications, particularly prevalent in hematologic malignancy patients, were significantly higher (13.9%) compared to other patient groups (3.5%). This underscores the importance of understanding factors influencing complication rates, such as chemotherapy-induced immunosuppression and prolonged neutropenia. The study's findings contribute valuable insights into optimizing the management of IAPCs for long-term intravenous access, emphasizing the need for ongoing research and refinement in this field.

The incidence of complications was significantly higher in hematologic malignancy patients. The higher incidence was strongly related to infectious complications. Hematologic

malignancy patients' higher incidence may be attributable to more intense chemotherapy, resulting in prolonged neutropenia, and also to direct impairment of the immune system by the disease itself [5]. Several studies reported higher rates of infection in patients with hematological malignancy [6-9]. It is thought that immunosuppression and prolonged neutropenia increase the risk in these patients [6]. In this study, we found that the rate of infectious complications in patients with hematological malignancies (13.9%) was significantly higher than in other patients (3.5%). We did not see an increased risk of complications with patients with head and neck, and breast cancers. Wang et al. [6] and Bos et al. [10] found an increased risk of complications in head and neck cancers. However, they emphasized that no definite interpretation could be made about the cause and that studies are needed on this subject [6].

In a study conducted with 2713 patients, it was found that only the increase in "number of punctures" increased the risk of complications, while the use of US reduced the risk of complications [11]. While high age was seen as a risk factor in some studies [12, 13], it was not seen as a risk factor in some studies like ours [11, 14]. While body mass index (BMI) was a

risk factor in the study of Nagasawa et al. [15], it was not seen as a risk factor in the study of Bademler et al. [11] and Hourmodzi et al. [16]. We could not analyze BMI as a risk factor because we could not reach sufficient data in our study.

Infections of port catheters include pocket and/or tunnel cellulitis or the more common catheter-related bloodstream infections. Early infections were evaluated due to contamination during the procedure. In late infections, thrombus and fibrin sheath are thought to be biofilms for infection [17]. Therefore, it is thought that there is a relationship between thrombus and infection in catheter infections. In order to prevent infection, procedures such as sterile hand washing, shaving and disinfection of the treatment area are performed. Still, infections are the most common complication after implantation of a venous port system [17, 18]. Moreover, the study of Nezami et al. [8] suggests that a single dose of preprocedural single-dose intravenous prophylactic antibiotic before totally implantable venous access port placement does not prevent short-term procedure-related infections.

In a retrospective study published in 2023, a total of 1406 port catheters were evaluated, revealing a significantly higher prevalence of hematologic malignancies in the infection group compared to the non-infection group. Furthermore, multivariate logistic analysis identified hematoma, preoperative hospital stay, chemotherapy history, and infection history as independent risk factors for infection. Similarly, our study, employing comparable statistical analyses, identified hematologic malignancy as a significant risk factor for port complications [19].

In a study published in 2022, the presence of a history of surgery, inpatient treatment, and hematologic malignancy in patients has been identified as a risk factor for early-stage port catheter infection. Additionally, the inpatient setting has been reported as a risk factor for late-stage port catheter infection [20].

In a 2023 study investigating the predictability of port catheter infections, it is recommended to avoid port implantation, especially in patients under antibiotic treatment or those who have

received antibiotic therapy within the last week, particularly in individuals with low serum total protein levels [21].

A strength of this study is the high number of patients in the sample and all procedures were undergone combined US and fluoroscopy guided. However, the study is not without limitations. Being a retrospective analysis, it is subject to retrospective collection of data, lack of documents, inherent biases, and limited control over confounding variables. Additionally, the study was conducted at a single institution, potentially limiting the generalizability of the findings to broader patient populations and practice settings. Another limitation is that we could not separately evaluate patients with chronic diseases such as diabetes mellitus, which may cause increased complications.

In conclusion, this research study sheds light on IAPC complications and the factors affecting complications related to IAPC. IAPC has a significant role with low complication rates for long-term intravenous access. The underlying hematologic malignancy was the independent risk factors of complications associated with IAPCs. Further research and ongoing efforts in this field are essential to continually refine and advance the management of imaging-assisted port catheters for the benefit of patients requiring long-term intravenous access.

Conflict of interest: No conflict of interest was declared by the authors.

References

1. Krupski G, Fröschle GW, Weh FJ, Schlosser GA. Central venous access devices in treatment of patients with malignant tumors: venous port, central venous catheter and Hickman catheter. Cost-benefit analysis based on a critical review of the literature, personal experiences with 135 port implantations and patient attitude. *Chirurg* 1995;66:202-207.
2. Gonda SJ, Li R. Principles of subcutaneous port placement. *Tech Vasc Interv Radiol* 2011;14:198-203. <https://doi.org/10.1053/j.tvir.2011.05.007>
3. Morris SL, Jaques PF, Mauro MA. Radiology-assisted placement of implantable subcutaneous infusion ports for long-term venous access. *Radiology* 1992;184:149-151. <https://doi.org/10.1148/radiology.184.1.1609072>
4. Bhutta ST, Culp WC. Evaluation and management of central venous access complications. *Tech Vasc Interv Radiol* 2011;14:217-224. <https://doi.org/10.1053/j.tvir.2011.05.003>

5. Samaras P, Dold S, Braun J, et al. Infectious port complications are more frequent in younger patients with hematologic malignancies than in solid tumor patients. *Oncology* 2008;74:237-244. <https://doi.org/10.1159/000151393>
6. Wang TY, Lee KD, Chen PT, et al. Incidence and risk factors for central venous access port-related infection in Chinese cancer patients. *J Formos Med Assoc* 2015;114:1055-1060. <https://doi.org/10.1016/j.jfma.2015.06.013>
7. Shim J, Seo TS, Song MG, et al. Incidence and risk factors of infectious complications related to implantable venous-access ports. *Korean J Radiol* 2014;15:494-500. <https://doi.org/10.3348/kjr.2014.15.4.494>
8. Nezami N, Xing M, Groenwald M, Silin D, Kokabi N, Latich I. Risk factors of infection and role of antibiotic prophylaxis in totally implantable venous access port placement: propensity score matching. *Cardiovasc Intervent Radiol* 2019;42:1302-1310. <https://doi.org/10.1007/s00270-019-02255-0>
9. Pandey N, Chittams JL, Trerotola SO. Outpatient placement of subcutaneous venous access ports reduces the rate of infection and dehiscence compared with inpatient placement. *J Vasc Interv Radiol* 2013;24:849-854. <https://doi.org/10.1016/j.jvir.2013.02.012>
10. Bos A, Ahmed O, Jilani D, Giger M, Funaki BS, Zangan SM. Dual-lumen chest port infection rates in patients with head and neck cancer. *Cardiovasc Intervent Radiol* 2015;38:651-656. <https://doi.org/10.1007/s00270-014-0973-3>
11. Bademler S, Üçüncü M, Yıldırım İ, Karanlık H. Risk factors for complications in cancer patients with totally implantable access ports: a retrospective study and review of the literature. *J Int Med Res* 2019;47:702-709. <https://doi.org/10.1177/0300060518808167>
12. Ji L, Yang J, Miao J, Shao Q, Cao Y, Li H. Infections related to totally implantable venous-access ports: long-term experience in one center. *Cell Biochem Biophys* 2015;72:235-240. <https://doi.org/10.1007/s12013-014-0443-1>
13. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies. *Mayo Clin Proc* 2006;81:1159-1171. <https://doi.org/10.4065/81.9.1159>
14. Seok JP, Kim YJ, Cho HM, Ryu HY, Hwang WJ, Sung TY. A retrospective clinical study: complications of totally implanted central venous access ports. *Korean J Thorac Cardiovasc Surg* 2014;47:26-31. <https://doi.org/10.5090/kjtcs.2014.47.1.26>
15. Nagasawa Y, Shimizu T, Sonoda H, et al. A comparison of outcomes and complications of totally implantable access port through the internal jugular vein versus the subclavian vein. *Int Surg* 2014;99:182-188. <https://doi.org/10.9738/INTSURG-D-13-00185.1>
16. Hourmozdi JJ, Markin A, Johnson B, Fleming PR, Miller JB. Routine chest radiography is not necessary after ultrasound-guided right internal jugular vein catheterization. *Crit Care Med* 2016;44:804-808. <https://doi.org/10.1097/CCM.0000000000001737>
17. Machat S, Eisenhuber E, Pfarl G, et al. Complications of central venous port systems: a pictorial review. *Insights imaging* 2019;10:86. <https://doi.org/10.1186/s13244-019-0770-2>
18. Teichgräber UKM, Kausche S, Nagel SN, Gebauer B. Outcome analysis in 3,160 implantations of radiologically guided placements of totally implantable central venous port systems. *Eur Radiol* 2011;21:1224-1232. <https://doi.org/10.1007/s00330-010-2045-7>
19. Guan X, Yan H, Zhang J, Li Y, Zhou Y. Risk factors of infection of totally implantable venous access port: a retrospective study. *J Vasc Access* 2023;24:1340-1348. <https://doi.org/10.1177/11297298221085230>
20. Chang TC, Yen MH, Kiu KT. Incidence and risk factor for infection of totally implantable venous access port. *Langenbeck's Arch Surg* 2022;407:343-351. <https://doi.org/10.1007/s00423-021-02328-0>
21. Chen H, Yamane T, Haruyama T, et al. Predictors of central line-associated bloodstream infections in cancer patients undergoing chemotherapy through implanted venous access ports: a retrospective, observational study. *Transl Cancer Res* 2023;12:3538-3546. <https://doi.org/10.21037/tcr-23-1217>

Ethics committee approval: Permission was obtained from Pamukkale University Non-Interventional Clinical Research Ethics Committee for the study (permission date 08.12.2020, 23/73335 file number).

Authors' contributions to the article

M.T. and M.A. have constructed the main idea and hypothesis of the study. H.S.A. and H.G.Y. developed the theory and arranged/edited the material and method section. M.T., M.D. and K.A. have done the evaluation of the data in the Results section. Discussion section of the article written by M.T., H.S.A. and B.U.K. reviewed, corrected and approved. In addition, all authors discussed the entire study and approved the final version.