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Intravenous Port Catheter Implantation: Retrospective Study in Single Center Experience

İntravenöz Port Kateter İmplantasyonu: Tek Merkezli Retrospektif Çalışma

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ABSTRACT

Objective: Totally implantable venous access ports (TIVAPs) are widely preferred for oncology patients who need chemotherapy. Although peripheral cannula or catheter in a large vein may help chemotherapy treatment; some complications such as vascular irritation, thrombosis may interrupt the treatment. To avoid this interruption, TIVAPs are usually preferred. The aim of the study was to evaluate device related complications and safety with anesthesia team implanted TIVAPs.

Methods: This retrospective study was conducted on patients who underwent procedure for implantation of TIVAPs in our hospital between the dates of January 2017 - December 2020. The demographic data, vascular access side, complications seen related to TIVAPs insertion procedure, the number of removed catheters, reasons of removal of catheters were recorded.

Results: During this study period 700 TIVAPs procedure have been performed in our clinic. While 646 patients (92.3%) had right sided TIVAPs, 678 patients (96.8%) had TIVAPs inserted to subclavian vein. When the most common cancer seen in this patient group was colorectal cancer, hepatobiliary tract cancer group came second. Total number of removed catheters for some reasons was 107 which is 15.2% of all patients. When the causes for catheter removal were examined, it was discovered that although systemic infection was the most common reason (47 patients, or 6.7%), the number of patients with positive culture from the port was extremely rare (19 patients) (2.71%).

Conclusion: We think that when TIVAPs are inserted under ultrasound guidance and fluoroscopy control in the operating room, the incidence of complications will be relatively low. Especially in cancer patients, TIVAPs can be inserted and used safely with high patient comfort.

Keywords: Totally implantable venous access port systems, complications, patient safety, port infection

ÖZ

Amaç: Tamamen implante edilebilir venöz erişim portları (TIEVEP), kemoterapiye ihtiyaç duyan onkoloji hastaları için yaygın olarak tercih edilmektedir. Büyük periferik kanül veya kateterler kemoterapi tedavisini kolaylaştırsa da damar yolu irritasyonu ve tromboz gibi bazı komplikasyonlar tedaviyi kesintiye uğratabilir. Bu kesintiyi engellemek için genellikle TIEVEP'ler tercih edilir. Bu çalışmanın amacı anestezi ekibi tarafından yerleştirilen TIEVEP'lerin cihaz ile ilişkili komplikasyonlarını ve güvenliğini araştırmaktır.

Yöntem: Bu retrospektif çalışma, Ocak 2017 - Aralık 2020 tarihleri arasında hastanemizde TIEVEP implantasyonu yapılan hastalar üzerinde yapılmıştır. Demografik veriler, kateter takılan taraf, görülen komplikasyonlar, çıkarılan TIEVEP sayısı, çıkarma nedenleri kaydedilmiştir

Bulgular: Bu çalışma süresince kliniğimizde 700 TIEVEP takılmıştır. Altı yüz kırk altı hastada (%92,3) sağ TIEVEP varken, 678 hastada (%96,8) TIEVEP subklavyen vene yerleştirilmiştir. Bu hasta grubunda en sık görülen kanser kolorektal kanser iken, hepatobiliyer sistem kanseri grubu ikinci sırada yer aldı. Yüz yedi olguda (%15,2) çeşitli nedenlerle kateter çıkarılmıştır. Kateter çıkarılma nedenleri araştırıldığında her ne kadar 47 hasta (%6,7) ile en sık neden sistemik enfeksiyonsa da, TIEVEP'den alınan örneklerde kültür pozitif olan hasta sayısının 19 (%2,71) olduğu görülmüştür.

Sonuç: Tamamen implante edilebilir venöz erişim portlarının ameliyathanede ultrason rehberliğinde ve floroskopi kontrolünde yerleştirilmesi durumunda komplikasyon insidansının oldukça düşük olacağını düşünüyoruz. Özellikle kanser hastalarına TIEVEP'ler yüksek hasta konforuyla güvenle yerleştirilebilir ve kullanılabilir.

Anahtar sözcükler: Tamamen implante edilebilir venöz erişim port sistemleri, komplikasyonlar, hasta güvenliği, port enfeksiyonu

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INTRODUCTION

Intravenous chemotherapy can be administered by inserting a peripheral cannula or catheter into a large vein, but peripheral administration may cause vascular irritation and thrombosis (1). This may cause the vessels to be exhausted and interruption of treatment (2). There are three types of devices for this: implanted venous port systems, tunneled central catheters, and peripherally inserted central catheters. Implantable venous access ports are widely preferred for clinical oncology patients. When compared to external tunneled catheters, they have a number of advantages, including less infection problems and easier catheter maintenance (2,3).

The first implantable port system was placed in 1982 (4). Totally implantable venous access devices have become an essential component of the medical oncology practice, replacing the external catheters; owing to their ability to improve patients' quality of life and excellent compliance rates. These devices can be inserted into the subclavian vein or internal jugular vein through open surgery, under fluroscopic guidence (5,6).

The aim of the study was to evaluate device related complications and safety of TIVAPs implantion by anesthesia teams.

MATERIAL and METHODS

After the approval of Koç University Clinical Research Ethics Committee with the number of 2020.372.IRB1.149, the records of patients with intravenous port catheter implantation between January 2017 and December 2020 were retrospectively reviewed. The study included only catheters implanted by the anesthesia team and patients above the age of 18.

The demographic information from the patients' preoperative evaluation forms, as well as the operation performed based on the surgical reports, were recorded. It was noted from which department the patients were referred for TIVAPs implantation. The anatomic location of the port catheter was recorded in all patients. Potential complications like infection, positive bacterial cultures, thrombosis, termination of treatment, skin necrosis and catheter malfunction were recorded. Infection was considered when there was no other source of infection site in the presence of fever (body temperature >38.5 °C), blood cultures were taken from the port and a peripheral vein. Patient was consulted by the infectious disease committee and decision to remove the catheter was made by the infectious disease committee. When thrombosis was suspected clinically, it was diagnosed and confirmed by shoulder or retrosternal discomfort (7). During the follow-up in the files, the reasons for removing the catheters and the unusual events were recorded.

According to institutional policy during maintenance of the port catheter to avoid thrombosis the port was rinsed with a 5 mL solution of heparin sodium (100 IU heparin in 1 mL of isotonic saline). In accordance with hospital infection control committe recommendations 1 g of cefazoline iv was administered preoperatively.

Port Catheter Insertion Management

All port catheters were implanted and monitored by the same anesthetic team. Although the choice of vein for cannulation was left to the anesthesiologist placing the catheter, in our clinic, the right subclavian vein was frequently favored over the left because threading the catheter into the superior vena cava is technically easier (8). Preoperative anesthetic evaluations were performed on all patients who had been informed about the procedure and whose consent had been obtained prior to the procedure. General anesthesia was used for all TIVAPs implantation procedures. In all patients whose appropriate intervention site was determined, skin disinfection and sterile covering were performed. All vascular interventions were performed under ultrasound guidance (Figure 1). The exact position of the wire inserted through the needle was confirmed by fluoroscopy (Figure 2). The catheter placed over the wire was advanced up to the right atrium and visualized with fluoroscopy. Then, in the subclavicular supraareolar region, a port chamber was implanted beneath the skin (Figure 3, 4). The catheter was tunneled and carried to the port location, where it was attached to the port chamber. Subcutaneous and skin tissue were properly covered. A chest X-ray was taken after the procedure to rule out the presence of a pneumothorax.

A team of oncologists, infectious disease specialists, and anesthesiologists made the decision to remove the port catheter. Infection, thrombosis, treatment termination, catheter malfunction, and problems such as skin necrosis at the TIVAPs insertion site were all reasons for the TIVAPs to be removed.

The heparinization protocol of the port catheter was applied to all patients at the same dose by the anesthesia and oncology teams. The relevant clinical department and anesthesia team handled any complications or utilization problems that may arise with port catheters. The same anesthesia team kept a record of all of the patients' port catheter usage.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., 2017, Armonk, NY). The normality of continuous variables were investigated by Kolmogorov-Smirnov test. This study is a descriptive study. Descriptive statistics were presented using mean and standard deviation for normally distributed variables and median (minimum-maximum) for the non-normally distributed variables.

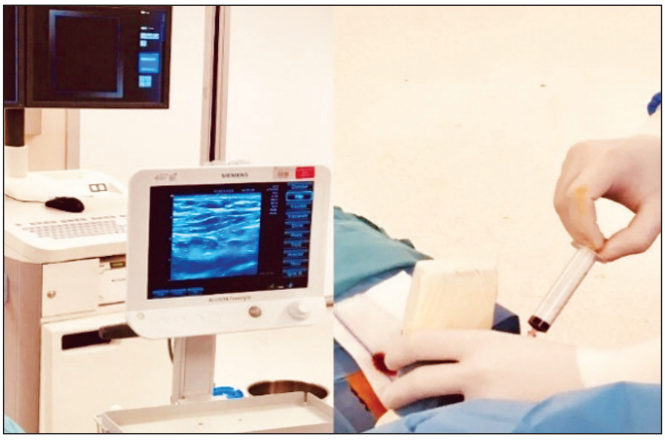

Figure 1: All vascular interventions were performed under ultrasound guidance.

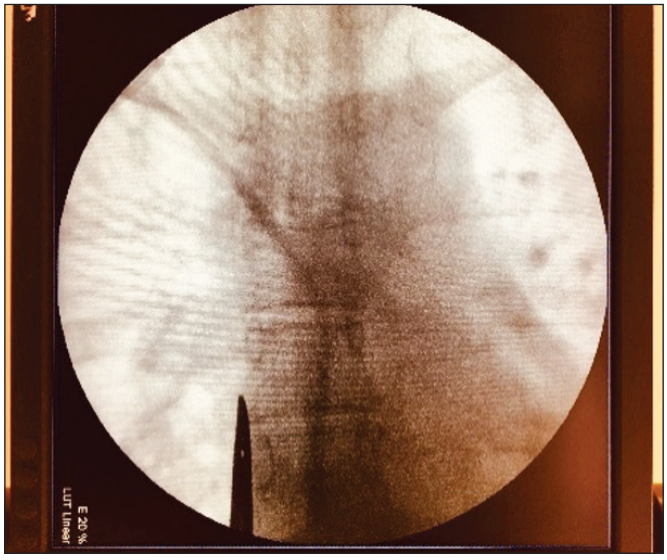

Figure 2: The exact position of the wire inserted through the needle was confirmed by fluoroscopy.

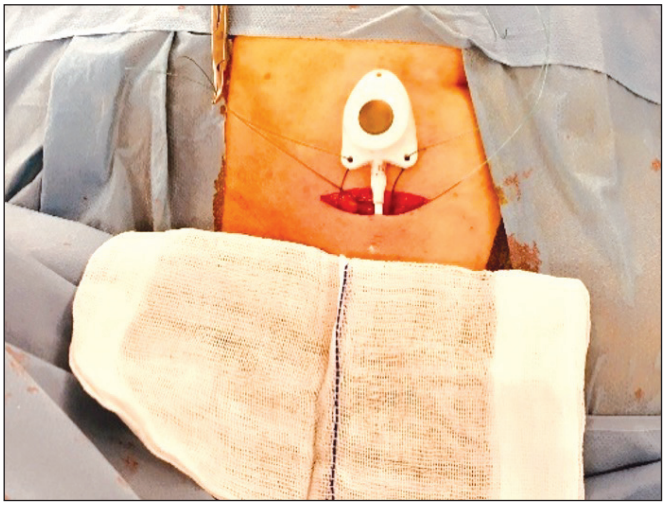

Figure 3: Port chamber right before implantation.

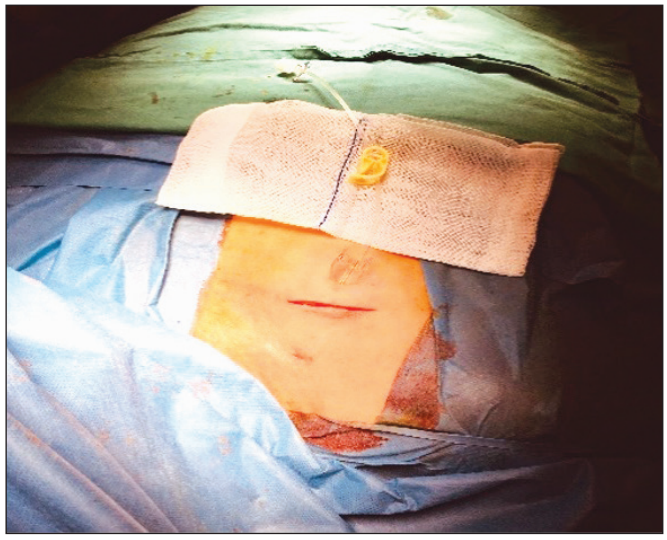

Figure 4: Subclavicular supraareolar region, a port chamber was implanted beneath the skin.

RESULTS

The files of 712 patients who underwent TIVAPs implantation in our clinic between the dates of January 2017 - December 2020 were retrospectively reviewed. Nine patients whose demographic data were not available were excluded from the study. Three patients were excluded from the study because the reason for removing the port catheter was not provided. The data of 700 patients who met the study's inclusion criteria were evaluated. Table I shows the demographics of the patients as well as the features of the vessel in which the port catheter was inserted. When the data was evaluated, it was revealed that all of the patients were cancer patients. The most common cancers were colorectal cancers. Totally implantable venous access devices were predominantly used on the right side and in the subclavian vein. All ports were 8.5 F catheters (Celsite, BBraun, Saint Cloud, France).

When the data were analyzed, 107 port catheters were removed due to different reasons (Table II). Approximately half of the port catheters were removed due to infection. The systemic infection rate was 6.7% (47/700) of all catheters inserted. Only 19 patients had positive culture which is 2.71% (19/700) of all patients. When the infected port catheters were examined, no significant difference was observed in terms of the inserted vein or side. There was no evidence of pneumothorax in any of the patients. Because the catheter in one patient was not working, an imaging approach was used. The catheter was ruptured, according to a radiological assessment. With the help of the invasive radiology team, the damaged catheter was removed at the catheter laboratory. The median duration to complication-related catheter removal was 153.9 (12-273) days (Table II).

Table I: Demographic and Descriptive Data of Patients

Total number, n	700
Age, (mean ± SD)	58 ± 13
Male, n (%)	339 (48.4)
Female, n (%)	361 (51.6)
Cancer, n (%)	
Breast cancer	70 (10)
Lung cancer	25 (3.5)
Colorectal cancer	204 (29)
Upper gastrointestinal tract cancer	95 (13.6)
Hematology cancer	62 (8.9)
Hepatobiliary tract cancer	132 (18.9)
Gynecology cancer	101 (14.5)
Others	11 (1.6)
Implantation side, n (%)	
Right	646 (92.3)
Left	54 (7.7)
Implantation vessel, n (%)	
Internal jugular vein	22 (3.2)
Subclavian vein	678 (96.8)

n: *Number of patients,* ***SD:*** *Standard deviation.*

Table II: Removed Port Catheter Features

Total number, n	107 (15.2)
Male, n (%)	70 (65.4)
Female, n (%)	37 (34.6)
Reason, n (% of all removed catheters)	
Infection	47 (43.9)
Positive bacterial cultures	19 (17.7)
Thrombosis	5 (4.7)
Termination of treatment	47 (43.9)
Skin necrosis	4 (3.7)
Others (not working)	4 (3.7)
Implantation side, n (%)	
Right	89 (83.2)
Left	18 (16.8)
The median duration to infection-related catheter removal (day), (min-max)	153.9 (12-273)

n: *Number of patients.*

DISCUSSION

Totally implantable venous access ports provide a secure and comfortable route for cytotoxic drug administrations for patients with malignancies. Although having TIVAPs implanted in the chest is generally thought to be the best option, some authors have explored other implantation sites to prevent complications such as pneumothorax and arterial punctures. Many centers have used a peripherally placed central catheter in the upper arm through the basilic or axial vein as an alternative to central venous access (9,10). Although having similar indications to chest TIVAPs, there is the perception that arm port implantation is an easier and less invasive procedure. Despite these advantages, to date arm ports have not been fully adopted in clinical practice because of the higher rates of late complications leading to failure and avulsion of the device. The majority of these complications are attributable to infections and thrombosis (11). Shiono et al. showed an overall incidence of complication rates of 7.3% and 5.2% in forearm and arm implanted ports, respectively (12). The majority of reported complications in these studies were infections and venous thromboses. Tippit et al. recently showed that the use of arm ports in breast cancer patients is responsible for a 9.5% incidence of upper extremity deep vein thrombosis, almost 5 times higher than what is observed for traditional chest TIVAPs (13). Reports in the literature would appear to indicate a somewhat higher incidence of complications and failures of arm ports as compared to chest ports, with infections and deep vein thrombosis being mainly responsible for these results. Therefore, in our clinical practice we prefer TIVAPs. We use chest ports because of both longer availability and less complication rates.

Immune system of cancer patients in the treatment period is mostly suppressed, these patients are more susceptible to infections. It has been shown in the literature that port catheters have a lower risk of infection than other central catheters, especially in immunocompromised patients. Infections are the most common complication after implantation of a venous port system. Infections of port venous systems include cellulitis or the more common catheter-related infections. The diagnosis is made by excluding other sources of infection by blood culture. Incidence of port-associated infection ranges from 0.6-27% in oncology patients (14,15). Identification of specific microorganisms and treatment can save the port system in the vast majority of cases.

Port-related infections can be classified as local infections, which are limited to the subcutaneous pocket or tunnel, and catheter-related bloodstream infections (CRBSIs). According to guidelines for the diagnosis and management of intravascular catheter-related infection issued by the Infectious Diseases Society of America, CRBSIs can be definitively diagnosed by demonstrating growth of the same organism from at least 1 percutaneous blood culture and from a culture of the catheter tip (16). These guidelines further recommend that cultures of the port reservoir contents should be performed in addition to catheter tip cultures when a venous access subcutaneous port is removed for suspected CRBSIs, citing increased sensitivity (17). In patients presenting with tunnel infection or port abscess, these guidelines recommend removal of the port, incision and drainage if indicated,

and antibiotic therapy without specific recommendations on catheter tip or port cultures. In our retrospective analysis, the diagnosis of port catheter infections was made in cooperation with the infectious diseases department, based on blood count and CRP levels, and all port catheters removed due to infection were sent to the laboratory for culture results. Antibiotic treatment was applied to 3 patients who were suspected to have infection according to laboratory values with no clinical signs of infection like pain, edema, erythema and sensitivity in the port area. Antibiotic treatment was sufficient for these 3 patiens and the TIVAPs were not removed. Although the port catheter was removed in all patients who were initially suspected of systemic infection, it was observed that this was not necessary in many patients after antibiotic treatment was administered.

Only 19 of the 700 patients in our case series had positive bacterial cultures, despite the fact that 47 of them were suspected of infection. Antibiotic treatment was given to all patients by infectious diseases specialists.

Causes of catheter obstruction could be bending of the catheter, an obstruction of lumen by fibrin plug or blood thrombosis, blockage of the administered drugs and fluids, the catheter tip adjacent to the vessel wall. Generally, the frequency of catheter malfunction has been reported to be 0.8-5% (15). Pinch off syndrome, in which the catheter is pinched or ruptured between the clavicle and the first rib, is a complication with pain, paresthesia and swelling in the port area, which is seen in 1.1-5% of the cases (18). In our case series we did not have any pinch off syndrome.

Skin necrosis was observed in 4 patients in our study. Skin necrosis is another complication of the port catheter which occurs in patients with thin skin and thin subcutaneous tissue or in the use of ports with higher than normal or sharp edges. Weight loss may cause this complication by reducing subcutaneous tissue. The port placed under the pectoral muscle or fascia can prevent skin necrosis. Large-sized ports were used in these 4 patients, and the patients were female. In these patients, the port site was revised and the skin was surgically repaired.

It has been reported in the literature that severe arrhythmia, embolism, arteriovenous fistula, vascular injury, brachial plexus damage and hematoma may develop during or after central venous port catheter implantation, none of these complications were observed in our case series (12). Experience of the anesthesiologists placing TIVAPs and ultrasound guidance in our clinic might have contributed to this outcome.

Port catheters can be inserted directly from central veins such as subclavian and jugular veins, or can be delivered to central veins from peripheral veins such as cephalic veins. The possibility of developing pneumothorax and hemothorax during subclavian vein puncture is higher (1.5-6%). In our clinical series pneumothorax or hemothorax were not detected neither radiologically nor clinically. Subclavian vein is preferred for port catheter application because of its short distance to vena cava and right atrium. The tip of the catheter should be in the lower third of the vena cava superior or at the junction of the vena cava superior and atrium. During port catheter insertion, fluoroscopic imaging is employed in our clinic, and the catheter tip is confirmed at the superior vena cava level.

Experience of the anesthesia team inserting the TIVAPs is important for both procedure success and lower infection rates. Patient satisfaction is also high in centers where TIVAPs are placed by a single experienced team (19).

Limitations

Our study was a retrospective study. The study consisted of records kept by our hospital's anesthesia department and port catheter unit.

CONCLUSION

We believe that when TIVAPs are placed in the operating room by a single experienced anesthesiology team under ultrasound guidance and fluoroscopy control, the incidence of complications will be relatively low. Especially in cancer patients, TIVAPs can be inserted and utilized safely with a high level of patient comfort.

AUTHOR CONTRIBUTIONS

Conception or design of the work: MM

Data collection: AI, BK

Data analysis and interpretation: MM, OE

Drafting the article: MM, SKC

Critical revision of the article: AI, KD

Other (study supervision, fundings, materials, etc): BK, SKC

All authors (MM, KD, AI, SKC, BK, OE) reviewed the results and approved the final version of the manuscript.

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