Infection Prevention in Practice 7 (2025) 100433

Available online at www.sciencedirect.com

Infection Prevention in Practice

journal homepage: www.elsevier.com/locate/ipip

The correlation between subcutaneous fat thickness and the incidence of chemoport-related infection

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ARTICLE INFO

Article history:
Received 23 July 2024
Accepted 30 November 2024
Available online 5 December 2024

Keywords:
Chemoport-related infection
Subcutaneous fat thickness
Computed tomography
Chemoport-related complication

SUMMARY

Background: This study aimed to examine the correlation between subcutaneous fat thickness and chemoport-related infection and to determine the risk factors that lead to complications associated with chemoport.

Methods: This study retrospectively reviewed 363 patients with chemoport insertion between May 2018 and May 2022. The patients were classified into three groups, with 121 patients in each group, based on the tertiles of subcutaneous fat thickness measured in the computed tomography (CT) scan. The incidence of short-term and long-term complications, including dislocation, infection, and malfunction, were obtained and compared between the three groups. The risk factors of chemoport-related complications were analysed in multivariate analysis.

Results: The incidence of infection in the low, middle, and high subcutaneous fat thickness groups were 1.7%, 3.3%, and 0%, respectively ($P = 0.131$). No short-term complications occurred in this study group. After one year of follow-up, 11 patients (3.0%) had long-term complications; 6 patients (1.7%) developed chemoport infection, while five patients (1.4%) had chemoport dislocation. In multivariate analysis, the risk of dislocation was significantly higher when insertion was performed via the left internal jugular vein (OR = 9.87, P=0.033).

Conclusions: The thickness of subcutaneous fat does not significantly correlate with the incidence of chemoport infection, and placement of the port on the left side of the chest wall via the left internal jugular vein is the risk factor for chemoport dislocation.

Introduction

Chemoport or port catheters are essential for providing long-term venous access, especially for cancer patients who require chemotherapy. These devices help reduce the risk of infection and thrombophlebitis while significantly improving the quality of life for patients undergoing treatment. The subcutaneous placement of the chemoport has several

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https://doi.org/10.1016/j.infpip.2024.100433

advantages, which include less inflammatory reactions, prevention of peripheral venous wall injury, and relief of pain and anxiety during chemotherapy treatments [1].

There are potential complications associated with subcutaneous chemoport, such as infection, malposition, malfunction, and device fracture, which can occur up to 33% of port devices [2–5]. One of the most common complications following chemoport implantation is infection, with an incidence of about 5.1% [6,7]. There are various factors which may be related to chemoport infection, such as haematological malignancy, leucopenia, hypoalbuminemia, diabetes mellitus, and the patient receiving palliative chemotherapy [8,9]. Although previous research has explored the factors contributing to chemoport complications, little attention has been given to investigating the relationship between subcutaneous fat thickness at the chest wall and infection risk [10,11]. Prior research has shown increased subcutaneous fat thickness is a risk factor for surgical site infection [12–14]. A study conducted by Shibata *et al*. demonstrated that a thinner subcutaneous layer between the mid-clavicular line and the paraumbilical region positively correlated with an increased risk of chemoport infection [15]. This observation led to the hypothesis that the reduced distance between the chemoport and epidermal layer may increase the risk of infection transmission, highlighting the potential influence of the patients' malnutritional state on their vulnerability to infection [15].

Our study aimed to examine the correlation between the incidence of chemoport infection and the thickness of patients' subcutaneous fat using computed tomography (CT) scan measurements before the procedure. This study will provide insights for patient preparation, clinical assessment, and the selection of appropriate insertion sites for future chemoport placements.

Methods

Study population

This was a retrospective, single-centre study. Six hundred thirty-two chemoport insertions performed from May 2018 to May 2022 in the interventional radiology unit were identified from the hospital database. After excluding 269 patients who had less than one year of follow-up (due to death, loss of follow-up or referral back to the primary unit), femoral port placement or no available chest CT within three months prior to the procedure, 363 patients' clinical information was collected from the electronic medical records.

Ethics statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Faculty of Medicine Ramathibodi Hospital, Mahidol University, protocol code COA. No. MURA2023/858.

Procedure technique

The chemoport insertion was performed in the angiography suite by an interventional radiologist or a radiologist with interventional fellowship training under the supervision of the attending physician. The risks, benefits, and potential procedural-related complications were explained, and informed consent was obtained before the procedure. Prophylactic antibiotics were administered intravenously around 30 minutes prior to the operation in all patients. An aseptic approach was used to prepare the skin of the neck and chest wall. Subcutaneous local anesthesia was administered at the puncture site and chest wall. The ultrasound-guided puncture of the right internal jugular vein was followed by the fluoroscopic-guided passage of a guide wire via the needle. Following that, the needle was removed. A peel-away sheath was inserted over the guidewire. A subcutaneous tunnel was created by using a metallic probe. A chemoport connected with an attachable catheter (Dignity® CT Ports, Medcomp®, Harleysville, Pennsylvania, USA; Celsite® Access Port, B.Braun Medical, Saint-Cloud, France; PowerPort TM Implantable Port, Bard access systems, Salt Lake City, Utah, USA) was inserted through the peel-away sheath. The chemoport was flushed with antibiotics and placed beneath the subcutaneous tissue at the right chest wall, 2 cm under the clavicle. A thoracic radiograph was conducted to ensure the location of the chemoport chamber and the catheter tip. Then, the subcutaneous tissue and skin at the neck and chest wall were sutured. Heparinization was performed on the chemoport. The patient has a follow-up appointment to evaluate any short-term complications in a week.

Data collection

Electronic medical records and clinical data were reviewed. Baseline clinical characteristics, prophylactic antibiotics, clinical laboratory, port type, port inserted site, short-term complications, and long-term complications were collected. Three hundred sixty-three patients were allocated into three groups according to subcutaneous fat thickness tertiles measured on CT images. The number of patients in each group was one hundred twenty-one.

Subcutaneous fat measurement

The thickness of subcutaneous fat was measured using chest CT scans (SOMATOM Sensation 64, Siemens Healthcare, Erlangen/Muenchen, Germany; Aquillion One, Toshiba Medical Systems, Japan; IQon spectral CT scanner and Philips, Netherland; GE LightSpeed Plus 4, General Electric Medical Systems, Milwaukee, WI, USA) performed within three months prior to the chemoport insertion. The subcutaneous fat at the midclavicular line level and the sternum level's upper border were measured in the mediastinal window of the axial CT scan image (Figure 1).

Outcome

The primary outcome was determining the association between subcutaneous fat thickness and chemoport-related infection. The secondary outcome measures were the prevalence of chemoport complications and the associated risk factors.

The diagnosis of short-term complications, including dislocation, infection, and malfunction, were within one week after the procedure. Long-term complications were the incidences of dislocation, infection, and malfunction that occurred more than one week to a year after the procedure.

Chemoport-related infection was defined as: Documented signs of infection on the skin overlying chemoport together with bacteraemia and that this infection was not caused by any

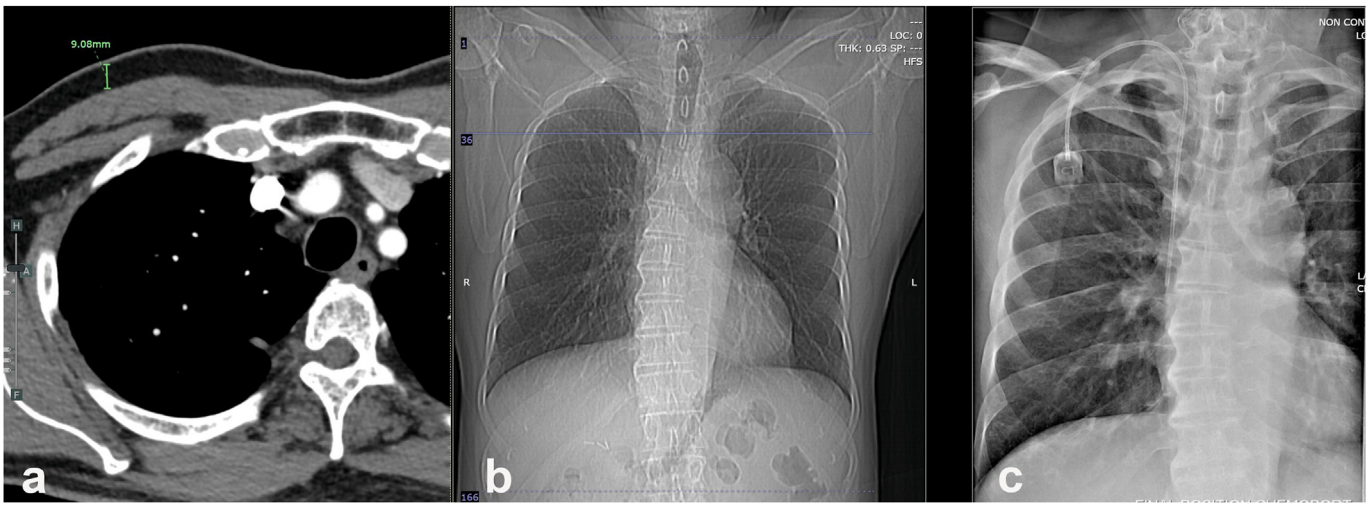

Figure 1. Measurement of the subcutaneous fat thickness at the midclavicular line with the upper border of the sternum level. (a) Axial CT scan image in mediastinum window (b) scout film chest within the same level of CT scan (c) chest radiography immediately after chemoport placement.

other source of bacteraemia, and consequently required the removal of the chemoport.

Statistical analysis

All statistical analyses were performed using STATA, version 17 (StataCorp, College Station, TX, USA). Categorised variables were summarised as counts and percentages and comparison between groups was performed using the Chi-square or Fisher's exact test.

The predictive factors for infection were analysed using univariable and multivariable analyses. Odds ratios (OR) and 95% confidence intervals were calculated. Two-sided *P*-values less than 0.05 were considered statistically significant differences.

Results

Demographic data

The 363 patients who underwent port implantation for chemotherapy and were included in the study were divided into three groups, with 121 patients in each group, according to tertiles of subcutaneous fat thickness. The medians of the low, intermediate, and high subcutaneous fat thickness groups were 5.5, 9.2, and 18.8 mm, respectively. The body mass index (BMI), sex, and port size in each group were significantly different ($P < 0.001$). There were no statistically significant differences in the other remaining demographic data, including age, chemoport location, absolute neutrophil count, and pre-procedural antibiotics, between the 3 study groups (Table I).

Association between subcutaneous fat thickness and chemoport-related infection

Subcutaneous fat thickness does not statistically significantly correlate with the risk of chemoport infection between these three groups. The infectious complications in the low, intermediate, and high subcutaneous fat thickness groups are 1.7%, 3.3%, and 0%, respectively ($P = 0.131$) (Table II).

Short- and long-term complications

The short- and long-term complications are demonstrated in Table II. After one year of follow-up, 11 patients (3.0 %) had long-term complications: 6 patients (1.7%) had chemoport infection, and 5 patients (1.4%) had chemo port dislocation. The incidence of infectious complication was higher in the high subcutaneous fat thickness group, 2 patients (1.7%), compared to the low, 4 patients (3.3%), and intermediate subcutaneous fat thickness groups, 0 patients (0%). The incidence of dislocated complication was higher in the group with high subcutaneous fat thickness; 4 patients (3.3%) compared with the groups with intermediate; 1 patient (0.8%) and low subcutaneous fat thickness; 0 patients (0%) (Table II). There was no statistical significance in either event.

There were no short-term complications in this study.

Infectious complications

The multivariate analysis for risk factors of infectious complications showed no statistically significant results (Table III).

Dislocated complications

On multivariate analysis, the site of chemoport insertion was found to be a significant risk factor for port dislocation (odd ratio [OR]: 9.87, 95% CI: 1.20—81.15, P=0.043). Subcutaneous fat thickness, BMI, age, sex, or port size were not associated (Table IV).

Discussion

The use of a chemoport for long term therapy has been shown to have fewer complications than tunnelled or non-tunnelled central venous catheters [16]. This is explained by the subcutaneous placement of the port, which is entirely covered by the skin. Increased subcutaneous fat thickness could increase the risk of surgical site infection [12—14].

Table I
Demographic and baseline characteristics of the patient between the three groups

	Low thickness group (N=121)	Intermediate thickness group (N=121)	High thickness group (N=121)	*P*-value
Subcutaneous fat thickness (mm)	5.5 (1.2–7.1)	9.2 (7.2–12.8)	18.8 (12.9–48.6)	<0.001
Age (years) (n,%)				0.089
<65	66 (55)	58 (48)	75 (62)	
≥65	55 (45)	63 (52)	46 (38)	
Sex (n,%)				<0.001
Male	92 (76)	78 (64)	22 (18)	
Female	29 (24)	43 (36)	99 (82)	
BMI (Kg/m^2) (n,%)				<0.001
<18.5	31 (26)	12 (10)	4 (3)	
18.5–24.9	83 (69)	80 (66)	63 (52)	
25–29.9	6 (5)	28 (23)	36 (30)	
≥30	1 (1)	1 (1)	18 (15)	
Port inserted site (n,%)				
Right-sided chest wall	119 (98)	116 (96)	112 (93)	0.089
Left-sided chest wall	2 (2)	5 (4)	9 (7)	
Port size (n,%)				<0.001
Low profile	110 (91)	107 (88)	75 (62)	
Standard	11 (9)	14 (12)	46 (38)	
ANC (/μL), (n, %)				0.296
≥1500	118 (98)	119 (98)	115 (95)	
<1500	3 (2)	2 (2)	6 (5)	
Antibiotic (n, %)				0.486
Cephazolin	117 (97)	115 (95)	112 (93)	
Ciprofloxacin	4 (3)	6 (5)	8 (7)	
Clindamycin	0 (0)	0 (0)	1 (1)	

Parametric data are presented as mean±standard deviation and categorical data are presented as number (percentage).
Nonparametric data are presented as median (min-max) and analyzed with Wilcox rank sum test.
BMI, Body mass index; *ANC*, Absolute neutrophil count.
*Statistically significant difference at $P<0.05$.

Conversely, reducing subcutaneous fat thickness may be a risk factor for infectious complications of the chemoport [15]. We believe that our study is the first to comprehensively measure the subcutaneous fat thickness in the area where the chemoport was placed. Our study found no statistical correlation between subcutaneous fat thickness and the incidence of chemoport infection.

This finding is inconsistent with the previous study by Shibata *et al*. [15], which found that a lower subcutaneous fat area statistically correlated with an increased risk of chemoport infection. This study explains that the lower subcutaneous fat area is a more accurate indicator than body mass index (BMI), which implies undernutrition status and increased risk of chemoport exposure. The study of Torun *et al*. also highlighted

Table II
Incidence of long-term complications between the three groups

	Low thickness group (N=121)	Intermediate thickness group (N=121)	High thickness group (N=121)	*P*-value
Complications (n,%)	2 (2)	5 (4)	4 (3)	0.518
Infection	2 (2)	4 (3)	0 (0)	0.131
Dislocation	0 (0)	1 (1)	4 (3)	0.067

*Statistically significant difference at $P<0.05$.

Table III
Multivariate analysis of risk factors for infectious complication

Variables	Multivariate analysis			
	Odds ratio	Std. error	*P*-value	*95%CI*
Subcutaneous fat thickness				
Low	(Reference)			
Intermediate	2.20	2.04	0.396	(0.35–13.51)
High	1.00	(empty)		
BMI				
<18.5	(Reference)			
18.5–24.9	0.51	0.52	0.507	(0.07–3.69)
25–29.9	0.7	1.10	0.853	(0.05–12.77)
≥30	1	(empty)		
Age				
<65	(reference)			
≥65	0.19	0.21	0.140	(0.22–1.71)
Sex				
Male	(reference)			
Female	4.15	3.87	0.143	(0.01–0.22)
Port size				
Low profile	(reference)			
Standard	1.83	2.21	0.612	(0.17–19.49)

Adjusted for BMI, age, sex, and port product.
BMI, Body mass index; Std. error, standard error; CI, confidence interval.

Table IV
Multivariate analysis of risk factors for malposition complication

Variables	Multivariate analysis			
	Odds ratio	Std. error	*P* -value	*95%CI*
Subcutaneous fat thickness				
Low	1	(empty)		
Intermediate	(reference)			
High	4.25	6.55	0.347	(0.21−87.08)
BMI				
<18.5	(reference)			
18.5−24.9	0.15	0.21	0.183	(0.01−2.45)
25−29.9	1	(empty)		
≥30	0.78	1.37	0.889	(0.03−23.99)
Age				
<65	(reference)			
≥65	0.33	0.41	0.371	(0.03−3.67)
Sex				
Male	(reference)			
Female	0.86	1.19	0.91	(0.57−12.96)
Port size				
Low profile	(reference)			
Standard	1.05	1.21	0.962	(0.11−10.06)
Port inserted site				
Right chest wall	(reference)			
Left chest wall	9.87	10.61	0.033[a]	(1.20−81.15)

Adjusted for BMI, age, sex, and port product.
BMI, Body mass index; Std. error, standard error; CI, confidence interval.
[a] Statistically significant difference at $P<0.05$.

that BMI does not reflect the distribution of adipose tissue but is correlated with ultrasound-measured umbilical, arm, and thigh subcutaneous adipose tissue thickness, respectively [17]. In our study, the subcutaneous fat thickness was measured using the axial image of the CT scan, specifically where the port was placed. This method differs from the prior study that measured subcutaneous fat area at the midclavicular line using semi-automatically detected and calculated based on the Hounsfield scale (−50 to −100 Hounsfield units). We believe this technique is more specific to measuring subcutaneous fat thickness than the whole fat density distribution in cross-sectional images. On the other hand, studies of surgical site infection, have found that increased subcutaneous fat thickness and BMI are significant predictor factors for incisional wound infection due to obesity-related morbidity and mortality, including reduced efficacy of antibiotics as a result of decreased tissue penetration or increased accumulation of seroma or hematoma in the dead space [12−14]. We did not observe an increase in the occurrence of infection in either the low or high subcutaneous fat thickness group, nor did we observe any short-term and long-term complications.

In this study, the overall incidence of chemoport complications was 3.03%, chemoport infection was 1.65%, and dislocation was 1.38%, which was a lower incidence than in prior research studies. The study from Yildizeli B *et al*. [18] and Shim J *et al*. [8] reported the incidence of complications, chemoport infections, and dislocations are 5.0−5.7%, 2.2−2.3%, and 3.1%, respectively. Compared to their study, their complication rate was higher, presumably due to subclavian catheterisation being done without any ultrasound guidance or assistance during the procedure. Shim *et al*. [8] included a higher proportion of patients with haematological malignancies which was associated with a higher incidence of catheter-related infection. The result and the outcome of a large retrospective study by Teichgraber *et al*. using the image-guided placement of a totally implantable venous port system reported that catheter-related infections were observed in 5.1% of cases [7].

A meta-analysis data [19] reported an infection rate of 0.93% (95% CI, 0.05−2.88) in the group of patients who received antibiotic prophylaxis for complete implanted venous access devices. Our data showed a slightly higher infection rate compared with the infection rate reported in the meta-analysis data. Nevertheless, these data include monitoring the patient for 30 days following the procedure. While our study collects data up to a one-year follow-up.

In multivariate analysis, our study did not find the following risk factors—port location, port size, or neutropenia—to be predictive factors for chemoport-related infection. One possible explanation is that the occurrence of the complication is too small to display significant differences among the three groups.

Contrary to previous studies, BMI did not have a significant impact on the occurrence of catheter-related infections or early removal of the chemoport [9,20−22]. This association is likely to attributed to alterations in hormonal or immunological status, which render obese patients more susceptible to infections.

The randomised control trial reported by Jones *et al*. demonstrated that the risk of early infection is 2.5 times greater than when the central venous catheter was placed on the right compared to the left [23]. However, the underlying mechanism behind this outcome remains unexplained. Earlier reports had noted that the location where the catheter is inserted had not been confirmed to be a determining factor for catheter-related bloodstream infections (CRBSI) in haematological illnesses [24]. To our knowledge, no previous study has examined the size of the chemoport in relation to infection.

Prior studies had demonstrated conflicting results about the association between neutropenia and chemoport infection. Studies have shown that neutropenia is a risk factor for catheter-related infection as a result of the compromised immune system [25,26]. Our study found no significant association between infection and neutropenia, consistent with results reported in other studies [9,21,27,28]. This outcome may reflect the administration of pre-procedure prophylactic intravenous antibiotics to all patients in our study.

Only the positioning of the port of the left-sided chest wall has been found to be independently associated with a higher risk of dislocation complications. Previous research has reported an association between right-sided catheterisation and an increased risk of malposition [29,30]. However, these studies research subclavian placement of the long-term central venous catheter without using fluoroscopic guidance. Our study corresponds with the prior research by Yaacob *et al*., which showed that insertion into the left-sided internal jugular vein (IJV) is associated with a higher incidence of complications [31]. This could be attributed to the blood circulation and the increased length of the catheter, along with the more acute angles formed by the left internal jugular vein as it connects to the left subclavian vein and left brachiocephalic vein, ultimately leading to the superior vena cava (SVC), compared with the right internal jugular vein's connection to the SVC [32,33].

The limitations of this study include its retrospective nature, being conducted at a single centre, and relying on the retrospective collection of periprocedural clinical data and outcomes, which frequently had insufficient documentation. The exclusion of patients who did not obtain a chest CT scan within three months prior to treatment (269 patients, 42.5%) may introduce further limitations in the results and lower the rate of complications, thereby impacting the statistical power in subgroup analysis. Despite the limited sample size, all chemoports were inserted using the same protocol, which included accessing the venous site with ultrasound and fluoroscopic guidance, administering prophylactic antibiotics, providing post-procedural care, and follow up for a specific period.

This study suggested that there is no substantial correlation between subcutaneous fat thickness and the incidence of chemoport infection.

Placement of the chemoport on the left side of the chest wall via the left internal jugular vein increased the risk of chemoport dislocation.

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Authors' contributions

Thanaphon Khongyut: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing — original draft preparation, Writing — review and editing, Visualization. **Tanapong Panpikoon:** Validation, Resources, Writing — review and editing. **Chinnarat Buangam:** Software, Investigation, Writing — review and editing. **Kaewpitcha Pichitpichatkul:** Resources, Writing — review and editing. **Tharinton Treesit:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing — review and editing. **Sasikorn Feinggumloon:** Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing — original draft preparation, Writing — review and editing, Visualization, Supervision, Project administration.

Funding

This research received no external funding.

Conflicts of interest

The authors declare no conflicts of interest.

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