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Port first vs. Tip first: does difference in portacath insertion techniques reduce complication rates

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Key words

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Abstract

Background: Accurate placement of central venous access devices is important to avoid complications such as infection, thrombosis and migration. This audit aims to determine if there is a difference in complication rates and accuracy of tip position between two different intravenous jugular (IVJ) port device insertion techniques: fixation of port first (PF) versus tip first (TF).

Methods: Patients who underwent port device insertions from 2019 to 2021 at the Cairns Hospital were identified from the Australia Vascular Audit database. The primary outcome of accurate catheter tip placement (based on radiological criteria), secondary outcomes of line infection, thrombosis and other outcomes such as removal rates were gathered and compared between the 2 groups of port first (PF) versus tip first (TF) insertion.

Results: Two-hundred and twenty-seven patients underwent port device insertions during the period of interest. 98 (43.2%) patients had a PF insertion technique and 129 (56.8%) had a TF insertion technique. In the PF group, 81.6% ($P < 0.05$) of lines were accurately placed compared to 69.8% ($P < 0.05$) in the TF group. The line related thrombosis rate was 1% ($P < 0.05$) in the PF group compared to 6.2% ($P < 0.05$) in the TF group. Rate of line infections in the PF group was 5.1% ($P = 0.92$) compared to 6.2% ($P = 0.92$) in the TF group.

Conclusion: The port first technique for IVJ port device placement was associated with higher accuracy and lower thrombosis rates and this was statistically significant. Further studies should involve larger multicentre populations to compare results between practitioners.

Introduction

Port devices are a type of totally implantable central venous access device that consists of a central venous catheter line and a subcutaneously implanted injection port.[1] They have the added benefit of allowing the patient more freedom of activity compared to other lines such as Hickman catheters due to the subcutaneously placed port.[1] Like all central lines, they have known complications such as line infections and sepsis, thrombosis, catheter migration, malposition or malfunction.[1]

Total complication rates of port device insertion range from 13% to 31%[1–3] where the two most common complications are line infection and thrombosis. Rates of port device related line infection range from 3.2% to 18.8%.[1–3] Rates of port device related line thrombosis range from 3.2% to 25%[1,3] for symptomatic clots requiring anticoagulation, and even up to 41% for asymptomatic thromboses in small vessels.[4] Catheter malfunction and tip migration are rarer complications described in port device insertions and these range from 2.4% to 9% in the literature.[2] Some studies have suggested that left sided catheters are more likely to migrate caudally[5] and different levels of surgeon experience might contribute to other complications such as iatrogenic pneumothorax.[2]

The optimal positioning of port device tips is important in reducing complications, especially thrombosis. However, this ideal tip location remains controversial.[5] We also know that catheter tips are not static and multiple patient and procedural factors affect this.[5] A tip placed high in the superior vena cava (SVC) is associated with a sixteen fold increase in thrombosis development[6] compared to a tip placed lower down in the SVC. These tips placed high in the SVC are also more likely to spontaneously migrate into the azygous system which can result in tracheo-azygous fistulisation.[7] A tip placed too low into the right atrium (RA) can lead to arrythmia, cardiac perforation and catheter dysfunction.[5]

As such, multiple different organizations recommend that the tip be located close to the junction of the SVC and RA.[8] However, there is no one reliable method specified to accurately determine

this ideal tip position of the cavoatrial junction (CAJ) and because actual venous structures cannot be visualized on a chest radiograph, surrogate landmarks have to be used to determine this ideal tip position.[8] Some studies have shown that use of intraoperative transoesophageal echocardiogram (TOE) to locate the catheter tip at the superior edge of the crista terminalis, a representation of the CAJ, resulted in more accurate tip placement.[9] However, not every centre has the capacity to utilize TOE intraoperatively and therefore, postoperative chest radiographs are more routinely used to determine tip position.

Accurate tip placement on chest radiographs across most literature is defined as: inferior margin right mainstem bronchus, 6th thoracic vertebral interspace, 2 vertebral body units below carina, above RA and within 2 cm of CAJ.[4–6,10] The accuracy of tip placement across the literature therefore has a large variation based on different measurement techniques but is in the range of 53%–92%.

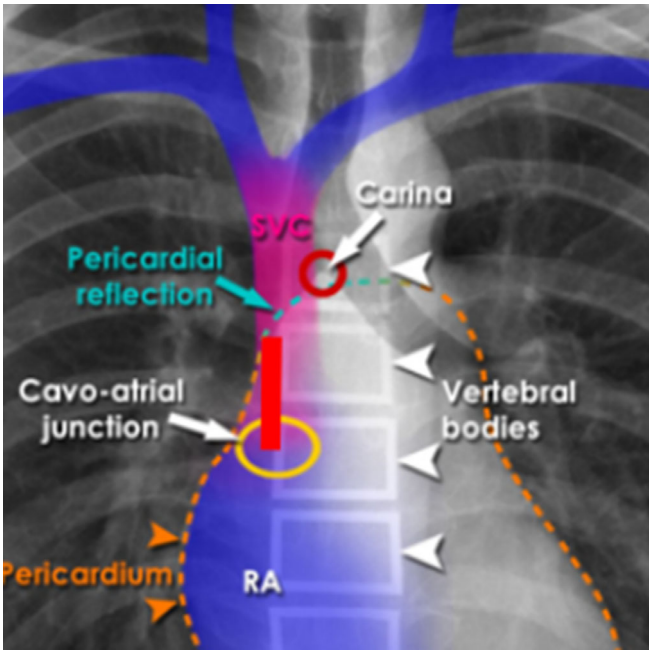

Fig. 1. Chest radiograph with red bar marking accurate tip location for intravenous jugular ports.

Previous studies have compared complication rates between different insertion techniques such as percutaneous versus open,[11] difference between catheters inserted into jugular versus subclavian veins[12] and differences between laterality of lines, but all of these catheters use the standard insertion technique by inserting the catheter tip first before securing the port at the chest wall. In this audit, we wanted to assess if there was a difference in tip accuracy and complication rates between two percutaneous insertion techniques of port devices: fixation of port first (PF) versus tip catheterisation first (TF).

Method

Ethics approval was sought and the Far North Queensland Human Ethics Research Committee has approved this study on the 5th of October of 2022.

Patients undergoing central venous line insertions at Cairns Hospital were selected during the period of January 2019 to December 2021. The Australia Vascular Audit database was used to select all consecutive cases during this period without any exclusions. Patients who had other central line insertions like Hickman catheters were then excluded and only patients who had intravenous jugular (IVJ) port insertions were included.

A retrospective snapshot review of the charts for these patients was done in June 2022 to assess for any complications to this date. Brands of ports were not considered relevant to this study and were

Table 2 Demographic data of patients and line characteristics for intravenous jugular ports inserted in Cairns Hospital, 2019–2021

Variable	Port first ($n = 98$)	Tip first ($n = 129$)
Gender		
Female	79	100
Male	19	29
Median age (years)	62	54
Anticoagulated	18	20
Indications for port Implantation		
Chemotherapy	93	121
Others	5	8
Laterality of line		
Left	20	35
Right	78	94

Table 1 Differences in operative steps between 2 methods for intravenous jugular port insertions in Cairns Hospital, 2019–2021

Port first method	Tip first method
(1) Percutaneous access of IJV	(1) Percutaneous access of IJV
(2) Guidewire into SVC	(2) Guidewire into SVC
(3) Subcutaneous pocket in anterior chest	(3) Peel away sheath over guidewire
(4) Port catheter tunnelled from chest wall into IJV	(4) Catheter fed through peel-away sheath
(5) Port connected to chest wall and secured with prolene	(5) Confirmation of tip position using fluoroscopy using different radiological landmarks as discretion of surgeon
(6) Catheter length measured using fluoroscopy with cavoatrial junction as landmark and appropriately shortened	(6) Creation of subcutaneous pocket
(7) Catheter delivery through peel away sheath	(7) Catheter tunnelled then shortened at chest wall and connected to port
	(8) Port secured into subcutaneous pocket

Table 3 Accuracy of catheter tip location, complication rates and their associated *P*-values (<0.05 being statistically significant) of two different intravenous jugular port insertion methods in Cairns Hospital, 2019–2021

Port first $n = 98$ (43.2%)		Tip first $n = 129$ (56.8%)		*P*-value
Accurate tip location	80 (81.6%)	Accurate tip location	90 (69.8%)	<0.05
Explantation	33 (34%)	Explantation	48 (37%)	0.7
Due to complication	7	Due to complication	16	
Planned removal	26	Planned removal	32	
Thrombosis	1 (1%)	Thrombosis	8 (6.2%)	<0.05
Infection	5 (5.1%)	Infection	8 (6.2%)	0.92

not specified in the operative notes. Three main brands of ports were used in Cairns Hospital during this time including Bard, Cook and Smith Medical.

Baseline demographics were collected for all patients by reviewing their electronic records, including gender, age and anticoagulation status. Line specific details were also collected, including indication, laterality and insertion technique. The primary outcome measured was accuracy of tip location and secondary outcomes measured included line thrombosis and line infection. Reason for line removal was also collected.

Post-operative chest radiographs were reviewed by the primary author and accurate tip location was identified as: inferior to where the right main bronchus crosses the SVC, between the medial border of the 6th and the 7th ribs/6th vertebral space, within 2 cm of CAJ and at the top of the right atrial bulge. This location is exemplified by the red bar in the chest radiograph below (Fig. 1).

The operative difference between the method of insertions for the two groups (port first and tip first) are outlined in the table below. In essence, in the tip first (TF) technique, catheter manipulation to connect to port happens after the tip position has been confirmed, thereby resulting in possible pulling back of the tip away from its initial confirmed position.

At completion of surgery, all surgeons would look at the final intraoperative imaging and the port would be considered adequate for use if it is able to be flushed, aspirated and deemed to be in adequate position by the surgeon (Table 1).

Statistical analysis of the results was performed with Chi square analysis and *P*-values <0.05 were considered statistically significant.

Results

Between January 2019 and December 2021 in Cairns Hospital, 300 patients underwent central venous line insertions. Of these, three were excluded as they were Hickman catheters. A total of 227 IVJ port device insertions were included. There was no missing relevant data.

Both groups were matched with respect to gender, age, indication for port device, anticoagulation status and line laterality (Table 2).

43.2% patients had a PF insertion technique and 56.8% had a TF insertion technique. 81.6% ($P < 0.05$) of lines in the PF group compared to 69.8% ($P < 0.05$) in the TF group had accurate tip placement based on the radiological definition. Most of the inaccuracy stemmed from the tips being too short/high in the SVC. Half of the ports in both groups were removed, mainly as they were not needed anymore but there were more ports removed in the TF group due to complications such as dislodgement, malposition, thrombosis and infection. The line related thrombosis rate was 1% ($P < 0.05$) in the PF group compared to 6.2% ($P < 0.05$) in the TF group. Rate of line infections in the PF group was 5.1% ($P = 0.92$) compared to 6.2% ($P = 0.92$) in the TF group (Table 3).

Table 4 No statistically significant association between laterality of intravenous jugular ports, thrombosis rates, line related infections and accuracy of tip location inserted in Cairns Hospital, 2019–2021

	Accurate tip position ($n = 170$)	Inaccurate tip position ($n = 57$)	*P*-value
Laterality of line			
Left ($n = 55$)	38	17	0.25
Right ($n = 172$)	132	40	
Presence of thrombosis			
Yes	7	2	0.84
No	163	55	
Line related infection			
Yes	10	3	0.85
No	158	54	

Out of the 227 IVJ ports placed, 172 were right sided and 55 were left sided. 76.7% of right sided ports had accurate tip placements compared to 69% in left sided ports. However, this was not statistically significant. Out of the ports with accurate tip placements, 4.1% were associated with line thrombosis compared to 3.5% in ports with inaccurate tip placements. 5.9% of ports with accurate tip placements were associated with line related infections compared to 5.2% in ports with inaccurate tip placements. Again, this was not statistically significant (Table 4).

Discussion

In our study, we focused on two different percutaneous insertion techniques for IVJ port devices with respect to tip accuracy, line infection and line thrombosis rates.

Our total tip accuracy rate of 69.8%–81.6% is within the rates of 53%–92% reported in the literature. Our study showed that although both PF and TF techniques were safe, the PF technique had a higher rate of tip accuracy. Most of the inaccuracy in the TF group stemmed from the tip being too short or too high in the SVC, fitting our hypothesis that in the traditional TF insertion technique, pulling back of the catheter tip when securing catheter to the port might be the reason. In the PF technique, there is less manipulation of the catheter as the port is already fixed prior to catheter introduction.

There was also lower line thrombosis and infection rates in the PF group. Our total line infection rates of 5.1%–6.2% falls within the reported line related infection rates of 3.2%–18.8% and our line thrombosis rates of 1%–6.2% also falls between the acceptable reported range of 3.2%–25%. Reported total complication rates of port device insertions are between 13% and 31% and the observed total complication rate of 10.1% in our population falls below the rates described in other papers.

In keeping with the literature, right sided ports were more common in our population and were also more likely to have accurate tip placements. This is likely as a result of easier access to the right internal jugular vein anatomically. Conversely, there were more line thrombosis rates seen in ports with accurate tip placements compared to ports with inaccurate tip placements. This is unlikely to be significant and could be attributed to the underpowered nature of this study.

This study was done as a retrospective single centre design. A power analysis was not done to determine sample size as there has been no previous literature to estimate the difference between the PF and TF methods for IVJ port insertions. Therefore, this study is likely to be underpowered. However, using the observed difference of 10% seen in our study, the power calculation is 68.6%.

Additionally, the PF method of insertion was performed only by a single surgeon while the TF method was performed by more than one surgeon at our facility. The experience of our surgeon doing the PF method could have contributed to the increased accuracy of placement and therefore, reduced complication rates. Accuracy of tip placement was determined with postoperative radiographs interpreted by a single unblinded medical practitioner who is not trained as a radiologist.

Final postoperative chest radiographs were obtained via a combination of intraoperative supine imaging and erect chest X-rays in recovery or the ward. The position of the catheter tip was reviewed by the proceduralist at the end of surgery and if it was able to be flushed and aspirated, it was considered adequate for use. Therefore, these catheters were acceptable to be used even though they did not meet our radiological criteria for accurate tip placement.

Conclusion

The port first (PF) technique for port device placement was associated with higher tip accuracy and lower thrombosis rates and this was statistically significant.

Author contributions

Sherab Bhutia: Conceptualization; data curation; methodology; resources; supervision; validation. **Hannah Tang:** Data curation; formal analysis; investigation; methodology; software; writing – original draft; writing – review and editing.

Conflict of interest

None declared.

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