Original Research

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Increased Complication Rate of Ports Placed into the Subclavian versus Internal Jugular Vein

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Purpose: Totally implantable venous access ports are commonly placed via subclavian or internal jugular (IJ) veins. The purpose of this study is to investigate the rate of radiographic abnormalities in clinically dysfunctional ports for subclavian versus IJ venous ports.

Methods: This retrospective study included 152 ports in 150 patients placed by multiple operators in both surgery and interventional radiology departments. Contrast-based, fluoroscopically guided vascular access studies performed for clinically dysfunctional ports from January 2019 to September 2020 were included. The port studies were evaluated for subclavian versus IJ access and to determine if there were radiographic abnormalities present, including catheter fracture, fibrin sheath, or catheter malposition.

Results: Of the 152 ports investigated, 30 were placed into the subclavian vein and 122 into the IJ vein. During vascular access checks, subclavian ports (n=23, 76.7%) demonstrated significantly more radiographic abnormalities compared to IJ ports (n=66, 54.1%, p=0.025). Of the dysfunctional ports with abnormal radiographic findings, subclavian ports were significantly more likely to have a major abnormality (n=15, 65.2%), defined as a malpositioned or fractured catheter, compared to IJ ports (n=21, 31.8%, p=0.005). The most common finding during vascular access checks for all ports investigated was no abnormality, with a well-functioning port and the catheter tip in an appropriate position (n=63; 41.4%).

Conclusions: This study suggests that for patients undergoing implantable port evaluation, ports placed into the subclavian vein are more likely to demonstrate a radiographic abnormality, as well as having increased likelihood of catheter malposition or fracture, compared to those placed into the IJ vein. Additionally, this study suggests that a relatively high rate of clinically dysfunctional ports referred for IR port checks have no demonstrable abnormalities on fluoroscopic port evaluation.

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Introduction:

Totally implantable venous access ports have been shown to improve patient's quality of life by providing reliable, long-term access to the venous circulation.[1] These ports are typically placed in patients that have chronic medical conditions requiring frequent lab draws and intervenous infusions, particularly infusions that can be damaging if administered in a peripheral blood vessel, such as chemotherapy. Both the subclavian and internal jugular (IJ) veins are used for access during port placement; both interventional radiologists and surgeons routinely place ports, with the choice of venous access usually based on physician preference.[1,2]

While port placement procedures typically incur few complications and ports demonstrate a durable lifespan, numerous clinical complications can emerge, such as poor aspiration, difficulty flushing, and pain at the port site.[1,3] To further assess the patency and position of these ports, contrast-based, fluoroscopic vascular access studies are completed to evaluate for common complications such as fibrin sheaths, malpositioning of the catheter, or catheter fracture.[1–5] These radiographic findings

would then guide decision-making about subsequent actions needed to restore venous access.

There are limited and conflicting reports in the literature comparing the complication rates associated with subclavian versus IJ vein access for port placement.[2,4–6] Therefore, the purpose of this retrospective study is to investigate the rate of radiographic abnormalities found during vascular access studies in clinically dysfunctional ports for subclavian versus IJ venous ports.

Methods:

Subjects

This single center, retrospective study was deemed exempt by the institutional review board. This analysis included 152 consecutive clinically dysfunctional ports in 150 patients who presented to a single vascular and interventional radiology (VIR) department from January 2019 to September 2020. The ports were placed by multiple operators in both surgery and (VIR) departments. All patients were referred for contrast-based, fluoroscopic vascular access studies, because of clinical port dysfunction. Gender and age of each patient was recorded.

Vascular Access Studies

Prior to the vascular access studies, the specific port dysfunction that prompted the referral was recorded, which included poor aspiration, poor flushing, difficulty accessing, pain and/or swelling at the port site, or "unspecified dysfunction." During the vascular studies, scout radiographs were obtained and ports were evaluated for subclavian versus IJ venous access based on radiographic appearance. Either before or after contrast injection through the port, radiographic abnormalities present were assessed, including catheter malposition, catheter fracture, or presence of a fibrin sheath. All ports underwent fluoroscopic evaluation prior to any potential treatment. Catheter malposition was defined as the tip of catheter being in the superior vena cava at or above the carina or positioned within another blood vessel. A fractured catheter was noted by extravasation of contrast outside of the catheter lumen. Fibrin sheaths were identified by retrograde movement of contrast along the walls of the catheter.

Abnormalities defined as "major" included malpositioned or fractured catheters, as these findings often require more invasive efforts by requiring an additional procedure to replace the catheter in order to restore venous access.[3,7–10] Since fibrin sheaths can be treated with a tissue plasminogen activator (tPA) infusion without a procedural intervention, this finding was not considered to be a major abnormality.

Throughout this investigation, statistical analysis was performed using STATA Version 16 (College Station, TX). When appropriate, student t-testing or chi squared-testing was utilized, with statistical significance designated as a p-value less than 0.05.

Results:

Sample characteristics of the patients investigated are presented in **Table 1**. Of the 152 ports investigated, 30 were inserted via the subclavian vein (19.7%) and 122 via the IJ vein (80.2%). 8/30 (26.7%) of the subclavian and 91/122 (74.6%) of the IJ were placed on the right side. The average age at vascular study of the two groups was not significantly different (p=0.13) with the mean age of the subclavian and IJ groups were 44.2 and 50.6 years, respectively. However, the subclavian group included 16 females (53.3%), which was significantly different (p=0.02) than the IJ cohort (91 females, 75.8%).

The most common clinical indications for port study referral were poor aspiration (n=55; 36.2%), "unspecified dysfunction" (n=50, 32.9%), poor flushing (n=17, 11.2%), pain and/or swelling at the port site (n=14; 9.2%), and difficulty accessing (n=13; 8.6%). 3 (2.0%) ports underwent vascular access because these ports had a prolonged period

Table 1. Sample demographics

	Internal Jugular	Subclavian	P-value	Total
Number of patients	120 (80%)	30 (20%)		150
Females (n,%)	91 (75.8%)	16 (53.3%)	0.02	107 (71.3%)
Age of patients, years				
Average	50.6	44.2	0.13	
Median	55	49		
Range	4 to 80	3 to 88		
Ports (n, %)	122 (80.3%)	30 (19.7%)		152
Left	31 (25.4%)	22 (73.3%)		
Right	91 (74.6%)	8 (26.7%)		

of time without usage.

A detailed breakdown of radiographic abnormalities found during vascular access studies is presented in **Table 2**. Notably, the most common finding during vascular access checks for all ports investigated was no abnormality with a well-functioning port and the catheter tip in an appropriate position (n=63; 41.4%). The second most common finding was a port with fibrin sheath present and the catheter tip in an appropriate position (n=53, 34.9%).

Subclavian ports demonstrated significantly more radiographic abnormalities compared to IJ ports (n=23, 76.7% versus n=66, 54.1%, p=0.025). Of the dysfunctional ports with abnormal radiographic findings, subclavian ports were significantly more likely to have a major abnormality compared to IJ ports (n=15, 65.2% versus n=21, 31.8%; p=0.005). Specifically, subclavian ports had significantly higher rates of radiographic dysfunction due to malposition (n=12, 52.2% versus n=19, 28.8%; p=0.043); however, dysfunction due to fracture was not significantly different between the two groups (n=3, 13.0% versus n=2, 3.0%; p=0.073).

Discussion:

In this retrospective study investigating the rate of radiographic abnormalities for clinically dysfunctional ports undergoing vascular access studies, subclavian ports not only had a higher rate of radiographic abnormalities, but also more often presented with major abnormalities compared to the IJ group.

One potential explanation for this difference may be related to the anatomic differences in the two veins. The subclavian vein originates as a continuation of the axillary vein at the lateral border of the first rib, transverses posterior to the clavicle, and then joins the IJ vein at the medial border of the anterior scalene muscle to form the brachiocephalic vein. Due to compression between the clavicle and the first rib, catheter pinch-off syndrome can occur, which has been associated with increased fractures and embolization of the catheter in subclavian ports.[4,11] This may explain the higher rates, albeit not statistically significant, of catheter fracture present in the subclavian (10.0%) compared to the IJ group (1.6%)

Another major complication of subclavian ports discovered in this investigation was that the catheter tip became malpositioned more frequently than IJ ports. This finding was also shared with a study by Plumhans, et. al, which found significantly lower rates of tip migration in IJ ports when compared to the subclavian ports.[6] One possible explanation for the increased rate of malpositioning in subclavian ports is that these ports must pass through the pectoralis

Table 2. Common Radiologic Findings Discovered on Vascular Access Studies

	Catheter Insertion Site		
	Subclavian (n=30)	Internal Jugular (n=122)	Overall (n=152)
Findings on radiographic imaging (%)			
Patent; appropriate position	23.3	45.9	41.4
Fibrin sheath; appropriate position	26.7	36.9	34.9
Patent; malpositioned in the proximal SVC	10.0	2.5	3.9
Patent; malpositioned in another blood vessel	6.7	1.6	2.6
Fibrin sheath; malpositioned in the proximal SVC	20.0	10.7	12.5
Fibrin sheath; malpositioned in another blood vessel	3.3	0.8	1.3
Fracture; appropriate position	10.0	1.6	3.3

muscles, which favor catheter movement during contraction.[6,12] Furthermore, due to anatomical positioning of the subclavian vein, a more lateral access site may increase the risk of catheter loops or curved catheter courses, resulting in catheter malposition.[6]

Additionally, this analysis discovered that for all ports undergoing vascular access studies, 41.4% were found to have no demonstrable radiographic abnormalities. These ports were also deemed to be clinically functional. This suggests that the use of vascular access studies to investigate clinically dysfunctional ports may be unnecessary if proper port function can be verified in the VIR department without radiographic evaluation. Given that the three most common clinical indications for port referral were poor aspiration, unspecified dysfunction, and poor flushing, efficient, minimally invasive maneuvers such as testing function with positional changes and saline flushes should be used prior to ordering vascular access studies.[3,7–10] Furthermore if clinically appropriate, thrombolytic flushes should be considered prior to vascular access studies, as a study by Sharma, et al. discovered that low dose alteplase injections through clinically occluded ports resolved 100% of the ports tested.[13]

This retrospective study has multiple limitations. First, this study only observed ports that were already deemed clinically dysfunctional and underwent vascular access studies. Therefore, this study does not address overall rates of dysfunction for subclavian and IJ ports, and future studies are required to further investigate this topic. Another limitation is that the two groups were statistically different in regard to gender. However, the impact of this discrepancy should be minimal, as gender likely plays a minimal role in causing radiographic abnormalities of these ports. Finally, these results cannot account for variability in operator skill or technique which may be responsible for more or less port dysfunctions.

Conclusion

In conclusion, for patients undergoing implantable port evaluation, ports placed via the subclavian vein were more likely to demonstrate a radiographic abnormality, including increased likelihood of catheter malposition or fracture, compared to those placed via IJ vein approach. Additionally, this study suggests that a relatively high rate of clinically dysfunctional ports referred for contrast-based fluoroscopic evaluation will have no radiographic abnormalities.

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