



Risk profile of subcutaneous port placement in small children

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ABSTRACT

Background/purpose: Long-term central venous access is a safe and common procedure in children. However, complications with devices are a reality. Smaller children are thought to have a higher rate of complication after port placement, and some surgeons avoid placing ports with an arbitrary weight cutoff out of concern for surgical site morbidity.

Methods: We performed a multi-institutional retrospective review of 500 patients less than 5 years of age undergoing port placement at three large volume children's hospitals from 2014 to 2018. Patients were divided by weight greater than or less than 10 kg at the time of insertion. Statistical analysis was performed to evaluate for differences in outcomes between the two groups.

Results: The majority of ports were placed for chemotherapy access (71.8%). Other indications included long-term infusions (18.8%) and difficult chronic IV access (9.4%). Of the 500 charts reviewed, 110 (22%) experienced some documented complication (28.9% <10 kg, 20.6% >10 kg, $p = 0.096$). There were no differences between the two groups in terms of the type or timing of complications. Overall, 16.3% of ports required removal prior to the end of therapy owing to a complication. Complication rate per day with the port in place was not different between the two groups (<10 kg: 0.68 complications/1000 port-days vs >10 kg 0.44 complications/1000 port-days, $p = 0.068$).

Conclusion: Weight less than 10 kg was not associated with a significantly higher incidence of any type of port complication in our cohort. This suggests that concern for complications should not exclude children less than 10 kg from port placement.

Type of study: Multi-institutional retrospective review.

Level of evidence: Level III.

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Reliable vascular access is a frequent necessity in children, with significant effort expended in both the inpatient and outpatient settings to obtain necessary labs and administer critical medications. Patients who are medically complex, have cancer, or have significant comorbidities are more heavily impacted [1]. Common indications for central venous catheters include chemotherapy, infusion therapies, long-term intravenous nutrition, or chronic difficulties with IV access [2–4]. Indwelling central venous catheters are frequently utilized to solve these problems but have their own set of complications and challenges.

A variety of different types of tunneled central venous catheters are frequently used in patients who require long-term vascular access. Ports have been invaluable for oncology patients for chemotherapy ad-

ministration since the 1980s and are the preferred mode of access in this population [5–8]. Other patient populations that often benefit from ports include those with cystic fibrosis, those with hematologic disorders, and medically complex patients requiring frequent IV access or blood draws [9,10].

Historically, surgeons have been reluctant to place ports in smaller patients, preferring externally accessed tunneled central venous catheters in this population. This preference stems from anecdotal concerns for wound healing and complications owing to relatively limited skin and soft tissue overlying the implanted device. Though case reports describe this, very little rigorous data exist to guide the surgeon in selecting the appropriate long-term venous access device in small children [11–13]. To answer this question, we planned a multi-institutional review of patients who underwent port placement. Patients were stratified by weight at the time of surgery to explore the risk of complications from port placement. We hypothesized that children less than 10 kg would not experience an increased incidence of complications compared to those greater than 10 kg.

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1. Methods

1.1. Study population

Approval for the study was obtained from the (University of Michigan) Institutional Review Board (HUM00163878) and at each participating institution separately. Three large, high volume children's hospitals participated in this retrospective study. A chart review was performed in patients less than the age of 5 who underwent port placement for any indication from January 1, 2014 through December 31, 2018. There are multiple types of tunneled central venous catheters and though the comparison is beyond the scope of this manuscript, for clarification purposes, those with a totally implantable venous access device (TIVAD) will be referred to as "ports" and those without (e.g. Broviacs, Hickmans, Groshongs, etc) will be referred to as "externally accessed tunneled central venous catheters." Multiple consecutive ports placed in the same patient were considered a separate placement for the purposes of analysis. Patients were excluded if they lacked adequate documentation to complete chart review.

Patients were stratified according to their weight at the time of port placement, based upon institutional dogma suggesting a cutoff of 10 kg, at which point surgeons felt the risk of wound complications would increase. Data collected included demographics, age and weight at the time of the procedure, indication for port placement, port insertion site, data regarding type and timing of complications, and timing and reasons for removal of the port. The primary outcome of interest was complication rate. Secondary outcomes of interest included types of complications and port longevity. Complications were categorized as *mechanical complications* (e.g. catheter malposition, inability to access the port, kinking of the line); *infectious complications* (e.g. surgical site infection, abscess around the implanted port, or central line infection, and including those requiring only antibiotics and those requiring port removal); and *wound complications* (e.g. dehiscence or skin erosion from the subcutaneous port). Complications were also analyzed by timing, with early postoperative complications occurring within 30 days of surgery and late complications occurring on or after 30 days. The groups were also analyzed by the number of ports remaining in place at 30 days, 90 days, and 1 year postoperatively. Since some ports were removed electively, we also analyzed whether the ports were removed as a result of complications at each of the above time points.

1.2. Statistical analysis

Sample characteristics are reported as number of observations and percentages for categorical variables and median and range for continuous variables. Chi-squared and Fisher's exact test were used as appropriate for categorical outcome measures. Student's t-test and Wilcoxon rank sum test were used to compare parametric and nonparametric continuous variables respectively, and Poisson regression was used to analyze the association between weight less than 10 kg at the time of placement and complication rate. All analyses were conducted in STATA v15.1, STATA Corp, College Station, TX, with a p-value less than 0.05 being considered statistically significant.

2. Results

2.1. Study population

A total of 500 patients less than age 5 underwent port placement during the study period, consisting of 83 patients less than 10 kg and 417 patients greater than or equal to 10 kg. Patient weight ranged from 2.9 kg to 29.9 kg, and only three patients were less than 5 kg (Table 1). There was a slight male predominance (61.6%). Overall, the most common indication for port placement was chemotherapy (71.8%), followed by need for long-term IV infusions (18.8%) and

difficult chronic IV access needs (9.4%). Patients greater than 10 kg in weight at the time of surgery were more likely to require port placement for chemotherapy, while smaller patients were more likely to need long-term infusions. Catheters were most commonly 6–7 Fr in size and placed at the right internal/external jugular or left subclavian locations.

2.2. Complications

Overall, 110 patients (22%) experienced a documented port-related complication, with 79 (73.6%) of these requiring removal or replacement of the port as a result, representing 15.8% of all ports placed. Of the 79 patients whose ports were removed, 50 (63.3%) were because of mechanical complications with the port (e.g. kinking of the line, inability to access the port, catheter malposition), 27 (34.2%) were because of infectious complications, and 2 (2.5%) were because of wound complications.

There was no significant difference between the two weight groups with respect to complication rate, type, or number removed. The most common complication group was mechanical complications (< 10 kg 19.3%, > 10 kg 11.8%) followed by infectious complications (< 10 kg 7.2%, > 10 kg 7.4%). There were eight total wound complications – four wound dehiscences (< 10 kg $n = 1$, > 10 kg $n = 3$), two small hematomas, and one with surfacing sutures from the wound. Only two of the patients required removal of the port owing to the wound dehiscence (one from each weight group). There were no differences in the timing of complications between the two groups. Table 2 summarizes these results.

Of the 500 port placements reviewed, 32 patients died with the port in place and 17 were lost to follow up. Among the remaining 451 port placements, there was no difference with respect to longevity of the port (Table 2). There was a significantly higher number of ports remaining in place at 30 days in the 10 kg or greater group; however, there was no significant difference at the 90 days or 1-year time points. There was also no significant difference between the groups with respect to timing of removal owing to complications (Table 3).

A total of 110 complications were identified among the 500 port placements, and across a cumulative 232,456 port-days. This corresponds to a rate of 0.47 complications per 1000 port-days. A trend toward higher complication rate was seen in smaller children, although not statistically significant (< 10 kg: 0.68 complications per 1000 port-days vs ≥ 10 kg: 0.44 complications per 1000 port-days, $p = 0.0683$).

Table 1
Population characteristics.

	Less than 10 kg ($n = 83$)	10 kg or more ($n = 417$)	p-values
Gender (% male)	63.9%	61.2%	0.644
Age at procedure (median years, IQR)	1.1 (0.7–1.4)	2.9 (2.0–3.9)	<0.0001
Weight at procedure (median kg, range)	8.8 (2.9–9.9)	14.8 (10.0–29.9)	<0.0001
Indications for port placement			
Chemotherapy	45.8%	77.0%	<0.0001
Difficult IV access	14.5%	8.4%	
Long-term infusion	39.8%	14.6%	
Catheter size			
Less than 6 French	24.4%	12.7%	0.003
6–7 French	75.6%	82.2%	
7 French or greater	0%	5.1%	
Site of catheter insertion			
Left external/internal jugular vein	14.6%	5.1%	0.005
Right external/internal jugular vein	43.9%	41.1%	
Left subclavian vein	39.0%	44.7%	
Right subclavian vein	2.4%	9.1%	

IQR: interquartile range; kg: kilograms.

Table 2
Outcomes.

	Less than 10 kg (n = 83)	10 kg or more (n = 417)	p-values
Any complications	28.9%	20.6%	0.096
Mechanical complications	19.3%	11.8%	0.063
Infectious complications	7.2%	7.4%	0.948
Wound complications	2.4%	1.4%	0.520
Timing of complication			
Intraoperative	1.2%	1.4%	1.00
Early postoperative	6.1%	3.1%	0.195
Late postoperative	22.2%	17.0%	0.265
Removed or replaced owing to complications	22.0%	15.2%	0.132
Port longevity (median days, IQR)	366.5 (206.5–757)	447 (233–804)	0.165

IQR: interquartile range; kg: kilograms.

3. Discussion

Reliable central venous access has dramatically improved the care delivered to children, but complications from these devices still exist. To our knowledge, this study is the first to closely examine the topic of port complications in small children. Overall, these young patients (<5-years-old) experienced complications at a rate of 0.47 per 1000 port-days. This finding is in line with existing literature that reports complication rates ranging from 0.15 to 0.90 complications per 1000 port days [6,8,10,14].

The hypothesis of this study was that children less than 10 kg would not experience an increased rate of complications, a question that has not been investigated previously. We found no statistically significant difference in complication rate, type or timing of complications, or proportion of ports removed owing to complication in children less than 10 kg compared to those greater than 10 kg. Furthermore, ports in children less than 10 kg had similar longevity to their counterparts greater than 10 kg.

In contrast to other published literature, the most common complications identified in this study were mechanical in nature. Most prior studies focused on infectious risk, particularly in oncology patients who are at higher risk owing to their immunocompromised state. Notably, several studies have demonstrated that infection risk is lower in ports than in tunneled central venous catheters [8,14]. Despite oncology patients comprising the majority of our cohort, however, only approximately 7% experienced infectious complications, and this was not significantly different between weight groups.

The primary concerns typically cited by surgeons with regard to insertion of ports in small children are skin breakdown and wound complications owing to their decreased amount of subcutaneous fat available to cover the port. Case reports, however, have demonstrated these complications to be quite rare [11–13]. Overall, wound complications in this study were also rare, occurring in 1.6% of patients overall and at a similar rate between the weight groups.

There are several limitations to this study. While the overall sample size is reasonable (n = 500) and the largest cohort published to date, the group of patients less than 10 kg is small (n = 83), likely owing to the reluctance of surgeons to place ports in this population. It is possible

Table 3
Port survival.

		Less than 10 kg (n = 77)	10 kg or more (n = 379)	p-values
Ports still in place (%)	30 days	94.1%	98.2%	0.047
	90 days	91.2%	94.4%	0.319
	1 year	51.5%	59.6%	0.212
Ports removed owing to complications (%)	30 days	3.6%	1.2%	0.132
	90 days	3.6%	3.4%	1.00
	1 year	13.3%	8.9%	0.222

that with a larger study population and more power to detect potential differences between the groups some differences would reach the level of statistical significance. However, any difference seems to be modest, and thus it is not advisable to avoid all port placements in children less than 10 kg who otherwise appear to be good candidates and stand to benefit from port placement. In addition to the inherent size and age differences in this study, we also noted a difference in the indications for port placement. Older children are more likely to undergo port placement for chemotherapy, and while there is no literature suggesting a higher risk of complications in this group, it is nevertheless a difference in baseline demographics that may confound our results. The smallest child in this study was 2.9 kg, and in fact, only three patients were less than 5 kg. We therefore cannot make strong recommendations on children at the lower end of this weight range. Our data collection did not include whether or not venous thrombosis was diagnosed after port placement, a complication that has been seen in small children requiring large diameter lines. Retrospective chart reviews have inherent biases and may not capture all events, including complications or procedures at hospitals other than the institution where the original device was placed. This review does not attempt to examine considerations around surgical technique, though there is evidence to demonstrate that certain specifics (such as the use of ultrasound guidance and the location of port placement) may decrease complications [3,9,15]. Similarly, we did not attempt to compare operative details such as need for anesthesia or operative time, as the primary focus of this manuscript is postoperative complications. Finally, this study does not address the rate of complications of ports compared to alternative modes of central venous access such as externally accessed tunneled central venous catheters within this population.

Despite these limitations, this study suggests that port placement in small children is not associated with a significantly increased risk of complication – including most notably wound complications – as has been hypothesized. In this study, only 15.8% of ports required removal owing to complications, less than what has been reported in the literature, with no difference in children less than 10 kg [1,16]. Given these findings, port placement should be considered even in small children who would otherwise benefit from this type of central access.

4. Conclusion

Ports can be safely used in children less than 10 kg without a clinically significant increase in the risk of complications requiring port removal. Surgeons managing vascular access in children can consider these devices for smaller patients with long-term access needs in addition to externally accessed tunneled central venous catheters.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpedsurg.2020.09.034>.

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