Burden of complications from needle penetration of plastic ports in children

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Background: Complications of totally implanted venous access ports are well documented. A concerning mechanical complication we have encountered is posterior penetration of plastic ports with the access needle. The purpose of this study is to investigate the burden of posterior penetrations.

Methods: We performed a retrospective review of all ports placed between November 2007 and December 2011 at a single institution.

Results: There were 247 children who received a port. 117 children (47%) received a port with a plastic posterior wall, 95 children (38%) received a port with a metal posterior wall, and 35 children (14%) had ports that were unable to be identified as plastic or metal. Posterior port penetrations occurred 8 times (3.2% overall, 6.8% of plastic ports). All perforations occurred in plastic ports of a single brand and product code. Average time from port insertion to penetration was 11.2 ± 21.3 months (range 0.3 to 63.4 months). Other complications included catheter malfunction (14), infection (9), pain (2), inability to draw/aspirate (4), leak (3), port migration (2), and malfunctioning not otherwise specified (15).

Conclusions: There is an unacceptably high risk of needle penetration of the posterior wall of plastic ports. We recommend utilizing ports with metal backing to avoid this complication.

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1. Methods

We performed a retrospective review of all ports placed by both surgery and interventional radiology between November 2007 and December 2011 at a single pediatric hospital. Institutional review board approval was obtained. Any ports placed beyond of the inclusion dates or at an outside facility were excluded. Electronic medical records were reviewed for demographic data, port use, port complications and/or port removal. Port perforation for standardization.

The longevity of implantable venous access devices (ports) is limited by infectious and mechanical complications. Several studies have described and quantified complications related to ports in adults and children including placement complications (air embolism, bleeding, vessel or thoracic duct injury, hemothorax, pneumothorax, brachial plexus injury, arrhythmia, tamponade), catheter complications (embolism, occlusion, damage, breakage, fibrin sheath formation), skin complications (inflammation, necrosis, scarring), septum malfunction, erosion, thromboembolism, dislodgement, leaking, and infection [1–11]. The adult literature estimates the rate of complications as 0.6%–12% for infection, 0.7%–6% for thrombosis, 0%–5% for device malfunction [11,3]. Complications resulting in the need for premature removal of the port are estimated at 1.0%–14.2% [11]. However, needle penetration of the port is not reported in the literature. Our recent experience has given us the clinical impression that plastic ports may pose an unacceptable risk of needle penetration of the posterior wall. Therefore, we reviewed our recent experience with port placement to investigate the burden of complications from needle penetration of the posterior wall of ports.

1. Methods

We performed a retrospective review of all ports placed by both surgery and interventional radiology between November 2007 and December 2011 at a single pediatric hospital. Institutional review board approval was obtained. Any ports placed beyond of the inclusion dates or at an outside facility were excluded. Electronic medical records were reviewed for demographic data, port insertion data, port use, port complications and/or port removal. Port penetration was defined as visualization of the access needle through the posterior wall of the port resulting in contrast extravasation under fluoroscopic interrogation. Any documentation of port penetration was verified by a review of images obtained during a fluoroscopic port study. The date of port removal was used as a surrogate for the time to perforation for standardization.

Data analysis was performed using 2-tailed t tests for continuous variables and Chi-squared test with Yates correction was used for categorical variables where appropriate. P values less than .05 were considered significant.

2. Results

There were 247 children who received a port between November 2007 and December 2011. Demographics are illustrated in Table 1. Most common indications for port placement included cancer (52%), hemophilia (12%), and transplant (8%). Interventional radiology
placed 17.4% of the ports while surgery placed 82.6%. Ports were left sided in 95 (38.5%) children and right sided in 152 (61.5%) children. The internal jugular vein was accessed in 122 (49.4%) children while the subclavian vein was utilized in 125 (50.6%) children. The majority of ports were placed on the anterior chest. Three brands of ports were utilized including AngioDynamics ports (Latham, NY, USA) (14%), Bard ports (Salt Lake City, UT, USA) (80%) and Deltec™ ports (Smiths Medical, Dublin, OH, USA) (5%). Port brand was unable to be identified in 3 children (1%) due to incomplete documentation. Interventional radiology inserted predominantly AngioDynamics (Latham, NY, USA) and Deltec™ brand ports (Smiths Medical, Dublin, OH, USA) while pediatric surgeons most commonly inserted Bard ports (Salt Lake City, UT, USA).

Ports with a plastic posterior were inserted in 117 children (47%) while 95 children (38%) received a port with a metal posterior wall. Thirty-five children (14%) had ports that were unable to be identified as plastic or metal due to incomplete documentation. Of those receiving a port with a metal posterior wall, 75 (73.7%) were entirely metal ports while 25 (26.3%) were plastic ports with a metal back. The access needles typically utilized were the non-corning Huber Gripper Plus® 20 gauge, 1.6 to 2.5 cm length safety Huber needle (Smiths Medical, Dublin, OH, USA). Access needle length was chosen based on manufacturer recommendations. Most commonly the 1.6 cm length access needle was utilized. On initial insertion of Bard ports (Salt Lake City, UT, USA), the access needle provided within the kit may have been utilized consisting of a 22 gauge 2.5 cm Huber needle or a 20 gauge 1.9 cm winged infusion needle.

Posterior port penetrations occurred 8 times (3.2% overall, 6.8% of plastic-backed ports) as verified on fluoroscopic port study (Fig. 1). One child received a replacement port and developed a second posterior wall port penetration 4.2 months after initial replacement. All perforations occurred in plastic ports with a posterior wall of a single brand and product code (Bard, 6603880, Salt Lake City, UT, USA). There were no port penetrations in metal ports or plastic ports with a metal posterior backing. All eight penetrations occurred in ports inserted by the surgery service into the internal jugular vein (6 into the right and 2 into the left internal jugular vein). Those with port penetrations all presented with symptomatology of device malfunction. There were no asymptomatic or incidentally discovered posterior port penetrations. Children with port penetrations initially presented with complaints of leaking from the accessed port site (50%), infiltration (12.5%), inability to flush/draw (12.5%), pain (12.5%) and malfunction not otherwise specified (12.5%). At our institution, it’s routine to obtain fluoroscopic imaging to interrogate ports that have become symptomatic and are suspicious for device malfunction. Due to the retrospective nature of this study, we were unable to delineate whether fluoroscopy was performed before or after removal of access needle that was present at initial onset of symptoms of malfunction. Other than requiring port replacement, there were no serious complications related to port penetration. After port removal, persistent leak from the posterior aspect of the port was able to be demonstrated (Fig. 2). Average time from port insertion to penetration was 11.2 ± 21.3 months (range 0.3 to 63.4 months). All 8 patients with port penetration underwent premature port removal (Fig. 2) and 6 required port replacement. The indications for port placement in those children who developed penetrations included cancer (71%), hemophilia (14%), end stage renal disease (14%), and cystic fibrosis (14%).

Complications occurred in 57 children resulting in an overall complication rate of 23%. Complications other than port penetration (14%) included catheter malfunction (25%), infection (16%), pain (3.5%), inability to draw/aspirate (7%), leak (5%), port migration (3.5%), and malfunctioning not otherwise specified (26%). The mean time from port insertion to complication was 14.6 ± 12.4 months (range 0.3 to 63.4 months). Port removal was performed in 138 children (56%). Eighty-one children had their ports removed due to completion of therapy (59%) while 57 children required premature port removal after developing complications. After removal, ports were replaced in a total of 38 children (28%). Nine children underwent more than one port replacement. Average follow-up time was 3.1 ± 1.2 years (range 1.1 to 5.3 year).

3. Discussion

Plastic ports were originally thought to be ideal for patients requiring imaging studies like MRI or CT scans in order to avoid interference of those images. In our series, posterior port penetration occurred in 7% of plastic ports inserted. It is possible that port penetration is under reported as this retrospective study only captured

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Table 1
Demographics.

<table>
<thead>
<tr>
<th></th>
<th>All (n = 247)</th>
<th>Non-penetration (n = 239)</th>
<th>Penetration (n = 8)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>6 ± 5.24</td>
<td>6 ± 5.25</td>
<td>1 ± 0.76</td>
<td>0.02</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>142</td>
<td>137</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>18 ± 3.8</td>
<td>18 ± 3.9</td>
<td>17 ± 2.3</td>
<td>0.37</td>
</tr>
</tbody>
</table>
those children that become symptomatic from their port penetration. No posterior port penetrations occurred with metal backed ports. There appears to be a lack of standardization in the definitions used to describe port complications [5]. Despite this, a review of the literature has not revealed any previous discussions of penetration of the posterior wall of ports. Further, this complication is not listed on the port manufacturer’s website [12]. Ports with a plastic posterior wall are associated with the unique risk for posterior port penetration that can be avoided by use of ports with a metal posterior wall.

The specific port resulting in all perforations is referred to as a Bard M.R.I. low-profile implanted port (Salt Lake City, UT, USA) and is thought to be ideal for pediatric patients due to its small size and MRI compatibility [12]. We are currently in the process of notifying the appropriate regulatory body of device malfunction. This port is a single lumen, 6.6 French venous catheter with a 10.8 mm septum diameter and a 10 mm height [12]. While the low profile design of these ports has cosmetic appeal, the shallow chamber depth in combination with a plastic posterior wall may contribute to the risk of penetration. AngioDynamics (Latham, NY, USA) and Deltec™ (Smiths Medical, Dublin, OH, USA) metal ports and plastic ports with metal backing are available in low profile models and are appropriate for CT use with minimal to no artifact. The use of ports containing metal can be advantageous as it allows for visualization under fluoroscopy in heavier children or those after steroid use who have access difficulty. Furthermore, these ports are also magnetic resonance imaging (M.R.I.) compatible up to 3 T making them appropriate for usage in most pediatric patients.

An appropriately sized non-coring needle should be used to access all ports to avoid cutting a hole in the silicone septum on insertion and to allow for the septum to maintain a seal after the needle is removed. Standard access needle lengths vary between 1.6 and 3.8 cm depending on the manufacturer. An appropriate access needle length should be chosen based on reservoir depth, tissue thickness and thickness of any dressing beneath the bend of the needle [12]. Children developing port penetration were significantly younger than those without port complications. Indeed, smaller children may be at higher risk of penetration due to the lack of overlying fat tissue and the proximity of the posterior wall to the surface leading to a higher risk of perforation. These non-coring needles are extremely sharp and can easily traumatize the plastic backed ports. Due to this, it’s important to use proper insertion technique and utilize an appropriate length access needle to avoid penetration.

In this series, the exact date of port penetration was not clear in all cases, thus all complications dates were estimated based on the date of port removal. Indication for fluoroscopic port interrogation was symptomatic port malfunction in all cases. Indication for port removal was thus symptomatic posterior port penetration in all cases. Time between diagnostic fluoroscopy and port removal was negligible in all cases as port removal was expedited due to symptomatic port malfunction. Only two port penetrations occurred shortly after initial placement (post operative day 10 and 16) while the rest occurred further out from placement. Thus, there did not seem to be a pattern of penetration relative to the time of insertion (i.e. early versus later access).

The limitations of this study include its retrospective nature, assuming all port insertions were captured. Institutional protocols from appropriate port access techniques and equipment were in place during the time of the study. Despite this, inappropriately sized access needles could have been utilized to access ports. While all episodes of port access on inpatient wards and in outpatient clinics were reviewed, port access incidents outside of our facility were unable to be reviewed. Furthermore, we are unable to conclude if port penetration was due to the production of ports with thin plastic posterior walled ports or secondary to the use of inappropriately long access needles. Likely, a combination of these factors led to port penetration.

It appears all ports that developed penetration were accessed by trained medical professionals in a clinic or inpatient setting. None of these ports were accessed at home. Six of port penetrations were in children treated for hematologic/oncologic disorders while the other two occurred in children who had their ports accessed by different teams for cystic fibrosis and renal disease. Given the variety of indications for port placement in those who developed penetration, we were unable to link port penetration to a single health care provider or clinic.

While all port penetrations occurred in ports placed by surgeons, this is due to the fact that only surgeons were utilizing plastic backed ports at our institution. Once posterior port wall penetrations complications were recognized, our institution moved to a single vendor with metal backed ports. While our institution has chosen to avoid implantation of any plastic backed ports, it’s important to know that plastic backed ports are still available for use. Thus, the possibility of port penetration needs to be acknowledged by providers in order to stress the importance of appropriate access needle usage and access technique.

References