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NEONATAL LYMPHEDEMA FROM THORACIC DUCT OBSTRUCTION COMPLICATING PERCUTANEOUS INTRAVENOUS CENTRAL CATHETERIZATION

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ABSTRACT

Percutaneous intravenous central catheter (PICC) complications are not common and generalized edema and anasarca in neonates as a complication of PICC malposition is even rarer. Documentation of the pathomechanisms of lymphedema in cases of severe anasarca in neonates is not often done. Here we document thoracic duct obstruction as the cause of lymphedema in a neonate with severe nonpitting generalized edema. Most PICC procedures should ideally be guided by point-of-care bedside ultrasound (US), and this precaution may prevent malposition of PICC lines although it will not detect subsequent migration or extravasation.

Keywords: percutaneous intravenous central catheter (PICC), edema, anasarca, lymphedema, lymphoscintigraphy, SPECT/CT, neonate, thoracic duct

Percutaneous intravenous central catheters (PICC) and central venous catheters (CVC) are routinely placed in neonatal intensive care units to provide intravenous fluids and parenteral alimentation. Complications include thrombophlebitis, infection, thrombus formation, catheter breakage, migration, malposition, extravasation, and tissue or vessel injury during insertion (1,2). We describe the first reported case in the literature of severe, transient lymphedema presenting as massive head and neck swelling associated with anasarca related to central lymphatic (thoracic duct) injury and obstruction which was directly visualized by lymphatic imaging. Lymphoscintigraphy with SPECT/CT accurately localized the site of thoracic duct obstruction in the absence of accompanying central venous obstruction.

CASE SUMMARY

A 3-day old male infant born at 39 weeks gestation with a birth weight of 3.5 kilograms developed abdominal distension and bilious emesis and was transferred to our institution for diagnostic evaluation and management. He was diagnosed with Trisomy 21 and Hirschsprung's aganglionic megacolon, requiring a colostomy. Echocardiogram showed mild pulmonary artery stenosis. Two weeks after placement, a left-sided PICC line with its tip just past the axillary vein in the proximal subclavian vein showed signs of extravasation and had to be removed. He subsequently developed massive edema initially over the upper half of the body and then anasarca, predominantly in the head, neck, trunk, and genitalia. The edema was firm, non-pitting and resistant to high doses of diuretics. He remained on ventilator and hemodynamic support for 5 weeks and reached a maximal weight of 8.0 kg, more

Fig. 1. Severe anasarca with predominant involvement of trunk, neck and head.

than double his birth weight (*Fig. 1*). Additionally, he had developed Enterobacter sepsis, bilateral pleural effusions, and a small thrombus in his right atrium. Ultrasound examination of the central veins did not detect thrombus or obstruction.

To elucidate the etiology of the anasarca, two sequential imaging studies with whole body nuclear medicine lymphoscintigraphy were performed after intradermal injection of 0.25 mCi technetium 99m labeled filtered sulfur colloid in a web space, initially of the feet and then of the hands. Imaging included dynamic, planar, and SPECT/CT imaging. Immediately after injection, dynamic planar imaging in one-minute frames was acquired for 15 minutes followed by whole body planar imaging. At approximately 40 minutes after injection, SPECT/CT was performed of the neck, chest, abdomen, and pelvis. Dynamic imaging of the legs demonstrated prompt migration of radiotracer superiorly with well-defined lymphatic channels. Subsequent whole body planar imaging showed further migration into the lymphatics and lymph nodes in the pelvis and retroperitoneum without evidence of radiotracer leak or retrograde reflux *(Fig. 2, left)*. A focus of radioactivity was seen in the left side of the upper mediastinum, which was confirmed by SPECT/CT *(Fig. 3)*. This accumulating activity corresponded to the expected location of the thoracic duct without evidence of leak.

A similar imaging protocol was used after injection into a finger web space of each hand. Dynamic imaging demonstrated prompt migration of radiotracer proximally with well-defined lymphatic channels and regional nodes. A linear focus of activity was seen in the left upper mediastinal region in the expected location of the lymph drainage of the upper extremity and neck into the thoracic duct confluence *(Fig. 2, right)*. No similar focus was seen in the right upper mediastinum. Subsequent planar imaging displayed this focus of radioactivity in the left upper mediastinum and demonstrated diffusion of tracer retrograde into cervical lymphatics and subcutaneous tissues of the neck. SPECT/ CT imaging further confirmed these findings. Even after 2.5 hours from the time of initial feet injections, there was no activity seen in the liver, which indicates that radiotracer still had not transited from the

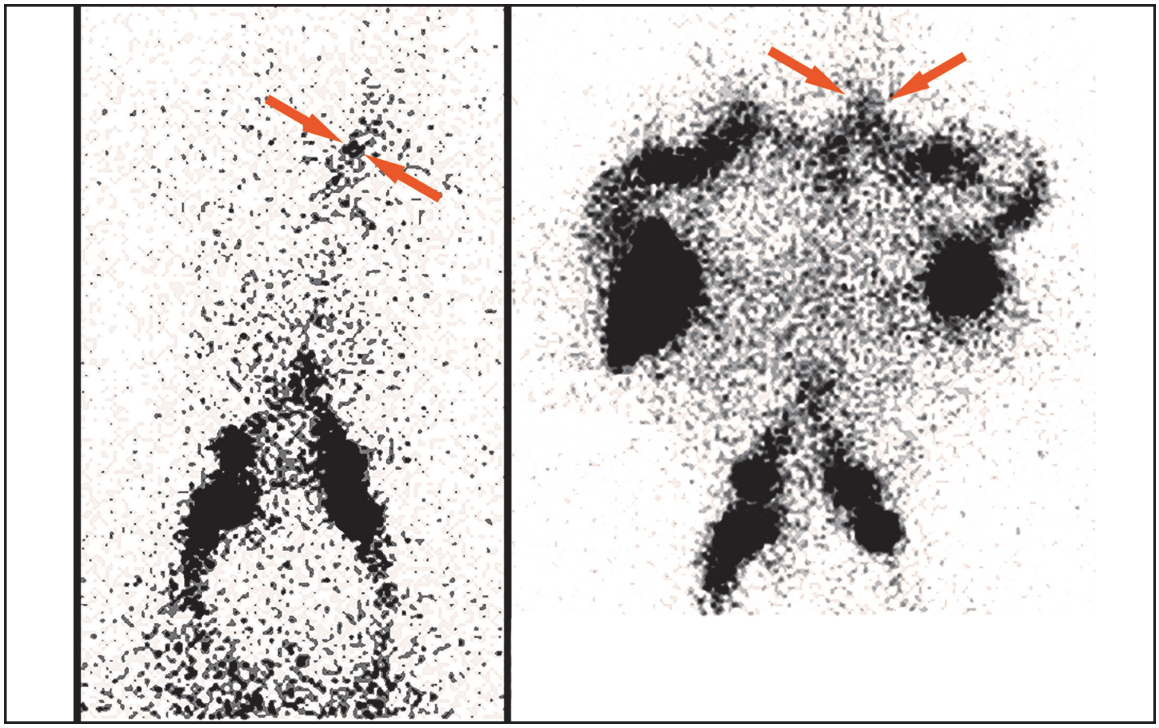

Fig. 2: Left image: Whole body planar imaging performed 67 minutes after injection of technetium-99m labeled filtered sulfur colloid in the web spaces between the first and second toes bilaterally. Normal lymphatic channels are seen in the legs and also more focal uptake in the pelvic nodes. Arrows indicate focal abnormal activity in the superior mediastinum. Right image: Whole body planar imaging performed 67 minutes after injection of technetium-99m labeled filtered sulfur colloid in the web spaces between the thumb and index finger bilaterally. Normal lymphatic channels are seen in the upper extremities. Arrows indicate focal abnormal activity in the left superior mediastinum and inferior neck.

lymphatic to venous system. These findings were consistent with obstruction of the thoracic duct in the region of its connection into the subclavian vein with reflux into cervical lymphatics and diffusion of radiotracer into the soft tissues of the neck.

Contrast-enhanced magnetic resonance imaging (MRI) of the chest (not shown) displayed generalized edema with additional localized edema and inflammation around the mediastinal blood vessels and right pleura. His central venous system was patent with good flow despite a relative narrowing of the right internal jugular and axillary veins with associated localized edema and/or inflammation possibly related to prior venous infusion extravasation.

At the time of transfer back to his hometown in northern Mexico at 2 months of age, his discharge weight was 4.2 kg. He was on full enteral feeds via nasogastric tube. At follow up at 18 months of age, he did not exhibit any edema.

DISCUSSION

Injury to lymphatic vessels can occur during insertion of CVC and PICC lines (1-4). Injury can also occur secondary to venous thrombosis, thrombophlebitis, and extravasation or infiltration (5-8). Even though the majority of lymphatic injuries are related to catheters placed on the left side, lines on either side of the body can result in

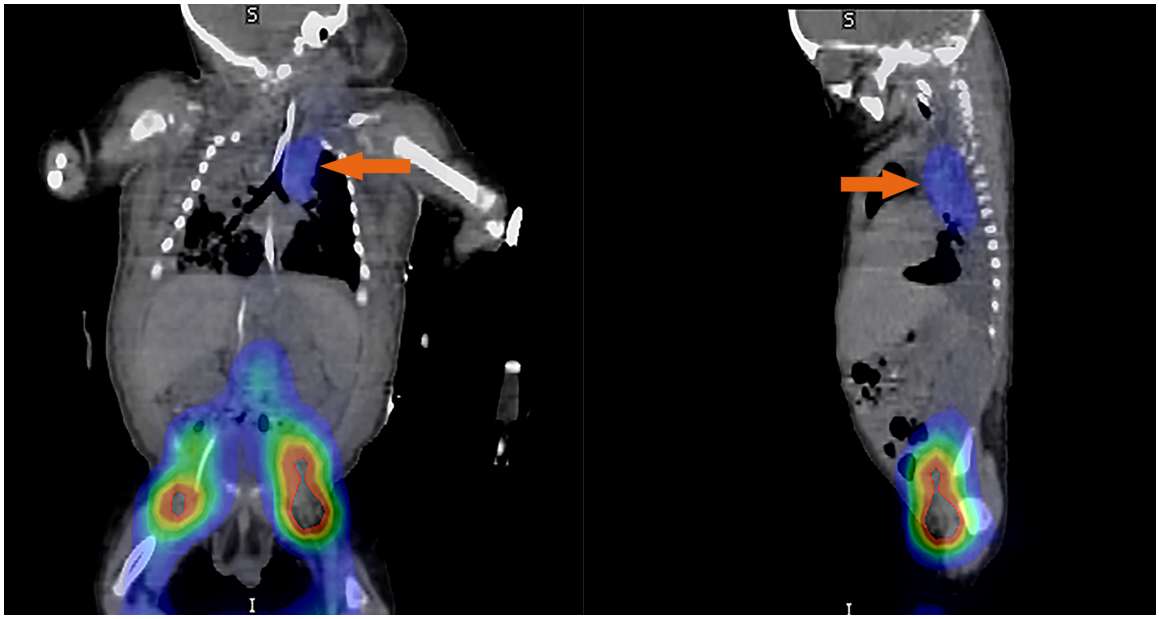

Fig. 3: Fused SPECT/CT images extending from base of skull through the thighs were obtained approximately 40 minutes after injection between toes and are displayed in the coronal (left) and sagittal (right) planes. Arrows indicate the abnormal activity in the left, superior and posterior mediastinum. The SPECT/CT is superior to the planar imaging (Fig. 2, left image) for anatomic localization.

lymph vessel damage (8- 12). These lymphatic injuries can result in chylothorax, chylopericardium, and chylous ascites (3,5,6). Generalized or massive head and neck lymphedema attributable to lymphatic injury is rare.

Lymphatic injury can be seen with all approaches for central venous access but is higher when a supraclavicular approach is used and lower when the lower limb PICC is used (13,14). In the majority of cases with neonates, PICC and CVC are not placed under fluoroscopic or ultrasound (US) guidance but in adults, these complications have occasionally been reported even when the lines were placed under US guidance (8,12,15).

Migration, extravasation, and infiltration are thought to occur more commonly when the tip of the CVC or PICC is not optimally positioned. The preferred position of the PICC tip is the cavo-atrial junction but this is often not achieved on the initial placement attempt. It is more common to have complications when the tip is not in a central location (5,16), including when the subclavian location is considered central (17). There is a misconception in many neonatal units that a malpositioned PICC or CVC could flip to an optimal location (1,18,19).

In a neonate, the definitive diagnosis of lymphedema and assessment of severity is often very difficult. In this patient with initial severe head and neck involvement and suspected thoracic duct obstruction, lymphoscintigraphy was the optimal imaging tool and the least invasive method for delineating abnormal lymphatic anatomy and/or lymph flow such as obstruction, leakage, reflux or dysplasia (20,21). Different protocols have been used in the neonate to define these abnormalities and to grade severity (22-25).

In the patient described, the postoperative chylothoraces resolved rapidly and were initially attributed to leakage from the central line insertion site. The subsequent

clinical picture of edema most severely in the head and neck was consistent with superior vena cava syndrome, which would not only obstruct venous but also central lymphatic return, a type of secondary lymphedema. However, multiple echocardiogram and ultrasound examinations as well as MRI showed normal central venous flow and no venous collateralization. The brawny abdominal wall and genital edema suggested a more generalized impairment of central lymphatic flow, which could have been partly due to a primary lymphatic developmental disorder. Trisomy 21 has a greater incidence of primary lymphatic problems prenatally with cystic hygroma and fetal hydrops and post-natally with peripheral lymphedema, which may not be noted at birth (26). The subsequent complete resolution of the edema is consistent with an acquired etiology for the lymphedema.

Conventional management options for lymphedema such as exercise, physical therapy, and compression would not have been applicable in this neonate or difficult to apply in the head and neck region. (20,21,27,28) Instead, gravity positioning in bed and gentle massage were undertaken with gradual resolution of the swelling, suggesting that lymphatic collateralization eventually restored flow from the lymphatic system into the systemic veins.

In summary, any severe persistent edema in the neonate might involve an anatomic or functional disorder of the lymphatic system primarily or secondarily. In the evaluation of neonates with edema of unclear etiology, lymphangioscintigraphy, particularly combined with SPECT/CT, is a non-invasive procedure for imaging the anatomy and physiology of disrupted, dysplastic, and obstructed lymph flow, and therefore potentially to guide therapeutic interventional radiologic or surgical procedures. Another lesson from this patient is that greater utilization of bedside US guidance for central line placement may reduce malposition and cases of iatrogenic lymphedema.

CONFLICT OF INTEREST AND DISCLOSURE

All authors declare that no competing financial interests exist.

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