FROM HEMO TO CHEMO: AN ENDOVASCULAR SOLUTION

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34 year old female with newly diagnosed poorly differentiated invasive ductal carcinoma of the left breast presents to interventional radiology 14 days after surgically placed right IJ chest port for chemotherapy.

- Intraoperatively, surgeon initially did not receive blood return through the port, but rather, air which was felt to be secondary to a faulty catheter. The surgeon then backed the catheter out over a wire and a new port was successfully placed with reported venous blood return and no air. Real-time fluoroscopy demonstrated the port-a-catheter tip within the SVC. Estimated blood loss 450 mL.

- The patient was experiencing persistent coughing in the PACU saturating 93% on 2 L nasal cannula. A post-operative portable CXR was performed (shown here).

- Thoracic surgery was called and a chest tube was placed yielding 400 mL of blood. The patient was discharged home with chest tube in place.
RELEVANT HISTORY

- **Past Medical History**
  - Recently diagnosed invasive ductal carcinoma.

- **Past Surgical History**
  - Left lumpectomy and sentinel lymph node biopsy/dissection 1 month prior to surgical port placement.
  - Surgical Powerport® (CR Bard Inc., Murray Hill, NJ, USA) placement 2 weeks prior to presenting to Interventional Radiology.

- **Family & Social History**
  - Nonsmoker, nondrinker, married with two children.

- **Review of Systems**
  - Noncontributory.

- **Medications**
  - None.

- **Allergies**
  - Sulfa.
DIAGNOSTIC WORKUP

- **Physical Exam**
  - Pre-port placement BP 126/82 HR 72 RR 16 O2 sat 100% on room air.
  - Post-port placement in PACU:
    - BP 93/56 HR 86 RR 18 O2 sat 93% on 2L nasal cannula.
    - General: No acute distress.
    - HEENT: Trachea slightly deviated to the left.
    - Lungs: Absent breath sounds on the right.
    - Cardiac: Regular rate and rhythm.
    - Abdomen: Nontender, nondistended.
    - Extremities: No clubbing, cyanosis, or edema.

- **Laboratory Data**
  - Pre-port placement H/H 14.0/41.0.
  - Post surgical port placement H/H 11.2/33.7 → POD#1 H/H 8.7/25.4 → POD #2 H/H 8.5/25.9.
  - On presentation to IR H/H 11.5/34.5.

- **Noninvasive imaging**
  - 14 days after surgical port placement, the patient presented for breast carcinoma staging CT.
1) What is the abnormality seen on the CT chest coronal images?

A: Rib fracture causing hemothorax.

B: Port-a-catheter traversing the right subclavian artery causing hemothorax.

C: Port-a-catheter traversing the internal carotid artery causing hemothorax.

D: Port-a-catheter in superior vena cava with residual hemothorax.
1) What is the abnormality seen on this cine of coronal images Chest CT with contrast?

A: Rib fracture causing hemothorax.

B: Port-a-catheter traversing the right subclavian artery causing hemothorax. The catheter is seen coursing through the right subclavian artery between the right vertebral and dorsal scapular arteries (1). The catheter tip extends into the posteromedial pleural space (2). Hyperdense fluid consistent with hemothorax is seen at the right lung base (3).

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CONTINUE WITH CASE
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CONTINUE WITH CASE
DIAGNOSIS

- Right hemothorax secondary to iatrogenic injury of the right subclavian artery with catheter tip in the posteromedial pleural space.
The patient was brought to the interventional radiology department for right subclavian arteriography prior to and following removal of the port-a-catheter.

Right subclavian arteriogram prior to catheter removal does not demonstrate any active extravasation due to tamponade effect of catheter against subclavian wall (left video). Subsequent subclavian arteriogram performed after removing the catheter over a wire demonstrates immediate extravasation of contrast into the right pleural space from the subclavian artery between the origins of the dorsal scapular and right vertebral arteries (right video). The catheter was immediately replaced for tamponade effect.
SUBCLAVIAN ARTERIOGRAM ANATOMY

- Ascending cervical artery
- Dorsal scapular artery
- Subclavian artery
- Internal thoracic artery
- Wire inserted in port-a-catheter tract
- Inferior thyroidal artery
- Right vertebral artery
- Source of extravasation
- Extravasation into pleural space

Course of injury

Source of extravasation
2) What is the purpose of this angiographic run before performing a right subclavian intervention?

A: Determine left vertebral patency.
B: Assess risk for potential right cerebellar infarct.
C: Determine left or right vertebral dominance of the posterior intracranial circulation.
D: All of the above.
2) What is the main purpose of this angiographic run?
A: Determine left vertebral patency.
B: Assess risk for potential right cerebellar infarct.
C: Determine left or right vertebral dominance.
D: All of the above. Infarction of the posterior intracranial circulation is a rare but potentially devastating complication of proximal subclavian endovascular stent graft placement across the vertebral artery origin. Risk of infarction is increased if the contralateral vertebral artery is hypoplastic.
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INTERVENTION:
SUBCLAVIAN STENT PLACEMENT

- Pre-deployment arteriogram (Figure A) was performed to confirm proper stent placement.
- A covered 8 mm x 5 cm stent graft (Viabahn®, Gore, Flagstaff, AZ, USA) was immediately deployed after the removal of the port-a-catheter. The stent graft was then dilated with a 8 mm x 4 cm balloon. The dorsal scapular, ascending cervical, internal thoracic, and right vertebral arteries were covered.
- Post-intervention arteriogram (Figure B) demonstrated no extravasation from the proximal subclavian artery. There was reconstitution of covered branches including the right subclavian artery via collateral circulation (not shown). The right common carotid artery is patent.
CLINICAL FOLLOW UP

- Following successful placement of the right proximal subclavian stent, the patient was sent to the operating room for video-assisted thoracic surgery and the right hemothorax was evacuated.
  - Approximately 1 L of bloody fluid and 300 mL of organized fibrohemothorax was decorticated off the lung and diaphragm allowing for complete lung re-expansion.
  - The patient received 2 units of packed red blood cells intraoperatively and a chest tube was kept in place and subsequently removed on POD#2.

- Upon discharge two days later, the patient’s hemoglobin and hematocrit were stable.

- 2 weeks later, a new right internal jugular Powerport® was uneventfully placed by interventional radiology, and the patient began chemotherapy treatments.
SUMMARY & TEACHING POINTS

- In summary, our patient was found to have an iatrogenically caused hemothorax secondary to injury of the proximal subclavian artery, which was treated with endovascular placement of a covered stent. The patient was found to be left vertebral artery dominant, and therefore covering of the ipsilateral right vertebral artery did not cause a posterior circulation infarct. The patient subsequently had a port placed by interventional radiology and began chemotherapy treatment without further delay.

- Overall complication rates of interventionally placed ports are similar to or better than surgically placed ports.\(^6,7\)

- Disadvantages of subclavian approach port placement:
  - Subclavian vein provides venous drainage of the upper extremity and catheter-related thrombosis can cause limb swelling and require anticoagulation or thrombolytic therapy.
  - Prone to becoming stenotic and should not be used in patient’s requiring hemodialysis.
  - Associated with the highest rate of pneumothorax.
  - Risk of catheter fatigue and “pinch-off” due to prolonged repeated compression against costoclavicular ligaments and subclavius muscle leading to catheter fracture and embolization.\(^3\)
Large retrospective study of 774 IJ versus subclavian approach port placement demonstrated lowest incidence of central venous thrombosis with IJ placement (0%).

The use of ultrasound for internal jugular catheter placement is a valuable tool in reducing the number of pneumothoraces and hemothoraces. However, there is documented risk of carotid puncture.

Complications during venipuncture can be reduced by:
- Real-time ultrasound guidance.
- Using micropuncture needles.
- Using a J wire instead of a straight tip wire during Seldinger technique.
- Taking special care not to advance the dilator too deep.
- Confirming a venous puncture by noting nonpulsatile venous flow.
SUMMARY & TEACHING POINTS (CONT.)

- Early complications from subcutaneous implantable venous access port placement include:
  - Pneumothorax: up to 2% incidence.¹
    - Study by Chang et al. of 424 patients revealed that immediate post insertion radiographs did not identify pneumothorax versus delayed radiographs 4-7 hours after placement revealed pneumothorax in 0.5% of patients.⁸
  - Hemothorax: up to 0.4% but fatal ~50% of the time according to recent case study.¹
  - Injury to the great vessels.
  - Air embolus.³

- Late Complications:
  - Infection- most common complication with a rate of 0.21/1000. Most commonly staph infection.³⁵
  - Fibrin sheath formation- most common cause of catheter dysfunction.
  - Central venous thrombosis due to catheter placement (Superior Vena Cava Syndrome).
  - Catheter pinch off.
  - Extraluminal migration of catheter.³

- Perform selective left and right vertebral artery angiography to determine vertebral dominance and therefore assess risk of potential cerebellar infarct before placing covered subclavian stent across one of the vertebral artery origins.


