Title: Direct percutaneous embolization of pulmonary arterial pseudoaneurysms: mixed bag of success and failure!

Exhibit Category: Thoracic procedures and interventions

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FINANCIAL DISCLOSURES

Ashu S Bhalla – None
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Pulmonary arterial pseudoaneurysms (PAP) are uncommon, but may present with life-threatening hemoptysis.

They are usually associated with catheterization, infection [(chronic cavitary tuberculosis (Rasmussen aneurysm) or mycotic] and penetrating trauma.

Other causes include septic emboli, lung neoplasm and vasculitis.
- Surgery: More Risks, GA needed, higher morbidity
- Coil embolization involves either occluding the PA branch containing the aneurysm or filling the sac itself with coils.
  - In case of central PAP, the former method necessitates sacrifice of first division branches of ipsilateral pulmonary artery.
  - Multiple coils needed for occluding the entire sac in second approach increases the cost of the procedure.
- Direct percutaneous embolization offers several advantages:
  - simple technique,
  - short duration of procedure,
  - reduced patient discomfort and
  - Shorter hospital stay and low complication rates.
INDICATIONS

- Patients with recurrence after / failure of coil embolization or those in whom feeding artery is not identified.

- Peripherally located aneurysms can be even more easily targeted without any risk of vascular injury.

- Adverse immunological reaction (in case of bovine thrombin), iatrogenic infection and non-target embolization are the primary concerns.
LEARNING OBJECTIVES

- To demonstrate the feasibility and technique of percutaneous thrombin / glue injection in the management of pulmonary arterial pseudoaneurysms (PAP) as a minimally invasive treatment option.
MATERIALS & METHODS

- We present our experience with 5 cases of PAP who were managed with percutaneous thrombin / glue injection.

- One was post-traumatic while the rest were mycotic pseudoaneurysms (one mucormycosis and other mixed bacterial infection).

- Procedure was done under using CT and/or USG guidance using 22G Chiba needle and human-derived thrombin or glue.
Thrombin preparations:
- **Floseal (Baxter Healthcare Corporation)** contains 5000 units of human-derived lyophilized thrombin and can be reconstituted with 10mL of 0.9% sodium chloride solution. The resulting thrombin solution contains 500 units per mL
- **TISSEEL kit (Baxter)** – human thrombin with CaCl₂ - 1, 2 & 5 mL vials (500 units / mL)

It should be noted that this is off-label use of thrombin.

Glue preparation: n-butyl cyanoacrylate, Endocryl: 0.5, 1 & 2 mL vials
CASE 1: POST TRAUMA

56-yr-male
Presented with left sided chest pain and heaviness x 1 month
Mild hemoptysis x 3 days
H/o fall from motorcycle 3 months back– no hospital visit at that time

CXR PA revealed consolidation left perihilar region and loculated left sided effusion
Axial, coronal and sagittal CECT images (a, b and c respectively) show large contrast-filled outpouching communicating with inferior division of left pulmonary artery with surrounding hematoma / consolidation and associated loculated hemothorax. (d) Gray-scale sonography image shows anechoic pseudoaneurysm showing yin-yang colour flow within on doppler (e).
The patient was taken up for percutaneous thrombin injection under USG guidance. (a) and (b) depict placement of Chiba needle (arrow) under sonographic guidance with its tip within the pseudoaneurysm. Subsequently 1000 units of thrombin were injected which led to progressively increasing echogenicity within the lesion. (c) Post-procedure USG shows that the previously anechoic pseudoaneurysm has now turned echogenic and does not show any flow within, indicating complete thrombosis.
Follow-up USG and CT showed complete thrombosis of the pseudoaneurysm. There was cessation of hemoptysis. Patient is doing fine at 1-yr follow-up.
CASE 2: MYCOTIC PSEUDOANEURYSM

52-yr-male CHRONIC DIABETIC
Presented with fever and cough x 1 month
Severe hemoptysis (250-300mL per bout) x 1 week
Bronchoalveolar lavage revealed mucormycosis

CECT Chest axial mediastinal window (a and b) and lung window (c) sections show large mycotic pseudoaneurysm in the left upper lobe, arising from the left pulmonary artery with surrounding consolidation (c)
Coronal CT angio \textbf{(a)} and venous phase CT \textbf{(b)} mediastinal window, clearly depict large communication between the left pulmonary artery and the pseudoaneurysm. \textbf{(c)} depicts CT guided needle placement into the pseudoaneurysm followed by injection of 2500 units of thrombin.
Post thrombin injection CECT (a) reveals non-contrast opacification of the pseudoaneurysm. Though imaging suggested thrombosis of the pseudoaneurysm, yet the patient remained symptomatic and mild hemoptysis persisted. Thus the patient was taken up for catheter angiogram. (b and c) Digital subtraction angiography (DSA) imaging subtracted mode with catheter tip in left pulmonary artery shows small stump of the pseudoaneurysm is seen from the superior division (arrow), with normal opacification of branches of inferior division.

- Since the patient remained symptomatic and DSA showed patent stump of the pseudoaneurysm, the patient was taken up for surgery.
- Post-operatively the patient is doing well at 6 months follow-up
CASE 3: MYCOTIC PSEUDOANEURYSM

65-yr-female
Presented with cough x 5 months, initially dry and associated with blood streaked sputum x 25 days
Completed ATT for pulmonary TB 1 year back
Underwent CT angiography and CECT chest

CT angiography revealed contrast-filled outpouching in left perihilar location (axial mediastinal window in a) which is seen to be arising from inferior division of left pulmonary artery, demonstrated on axial and oblique sagittal maximal intensity projection (MIP) images (b and c respectively).
Venous phase axial CECT images (d and e) mediastinal window revealed that in addition to the pseudoaneurysm (d), there was a large cavity with air-fluid level within and surrounding consolidation in left lower lobe (e and f).

Iodine maps generated by dual energy CT clearly depict the pulmonary arterial pseudoaneurysm in axial, coronal and sagittal planes (a, b, and c respectively).
The patient was planned for percutaneous thrombin injection. (a) depicts percutaneous placement of Chiba needle into the lesion under CT guidance. Then contrast mixed with reconstituted thrombin (2000 units) were injected (b). Patient had a violent bout of cough during the procedure. (c) Post procedure check scan demonstrates opacified pseudoaneurysm. Also note is made of contrast in the esophagus, likely due to aspiration in the bout of cough. Also, CT guided aspiration from the cavity with fluid level showed mixed bacterial infection.
CASE 4: GLUE EMBOLIZATION

- 34-yr-male, Renal transplant recipient 2 years ago
- Presented with fever and cough x 2 weeks
- Diagnosed to have angioinvasive mucormycosis and was being treated for the same, but the patient developed massive hemoptysis x 2 days
- Underwent bronchial artery embolization but hemoptysis persisted

CT Chest lung window shows multiple cavitating nodules in both lungs with bilateral mild effusion
**Glue embolization in Mycotic PAP**

(a) Axial and coronal (b) CT images in a case of angio-invasive fungal infection show PAP in a cavitating nodule in left lung. (c) depicts percutaneous placement of Chiba needle into the lesion under CT guidance followed by injection of 33% glue (n-butyl cyanoacrylate mixed with lipiodol). There was tract hemorrhage along the path of needle entry so latter was packed with gelfoam.
CASE 5: RECANALIZATION DESPITE GLUE EMBOLIZATION

-54-yr-male, known diabetic
-Presented with massive hemoptysis
-BAL revealed mixed fungal infection (mucormycosis & aspergillosis)

CT Chest mediastinal (a) and lung window (b) sections show right lower lobe consolidation with a contrast–filled outpouching. The corresponding vertebral body also shows permeative lytic destruction. (c) Sagittal bone window image depicts spondylodiscitis with vertebral body involvement, likely tubercular in etiology.
(d) Sagittal maximal intensity projection (MIP) image shows that the pseudoaneurysm is arising from the segmental branches of inferior division of right pulmonary artery. (e) Volume rendered image view from posterior depicts the same.
(a) Depicts placement of Chiba needle into the pseudoaneurysm sac under CT guidance. Intravenous contrast was injected to check the position of needle tip. (b) depicts glue-lipiodol mixture being injected. (c) and (d) show final distribution of glue-lipiodol mixture, completely filling the pseudoaneurysm sac and going distally.
The patient had significant improvement but streaky hemoptysis continued. Axial (a) and coronal (b) post contrast MR angiogram images demonstrate recanalization of the pseudoaneurysm.

The patient was planned for surgery; however had a massive bout of hemoptysis and died.
DISCUSSION

- Thrombin was used in 3 cases while glue injection was done in 2.
- Technical success could be achieved in all the patients (with thrombosis of the pseudoaneurysms) but two patients eventually required surgery (one died before surgery).
- There was significant residual hemoptysis in one patient (mucormycosis) despite technical success, which was eventually managed surgically.
- One patient had recanalization of the PAP and died because of a massive bout of hemoptysis.
- Real-time ultrasound guidance was used in one patient while rest were done under CT guidance.
DISCUSSION

- 22G Chiba needle was used in all cases and position was confirmed by blood spurt and lipiodol / contrast injection under CT guidance. Intravenous contrast to opacify the PAP was given in one patient after needle placement to confirm tip position.

- There was no need of general anesthesia in any patient.

- No significant immediate / delayed complications were encountered.

- One patient had severe bout of cough after thrombin injection, resulting in mild aspiration which was clinically silent.
PROCEDURAL TIPS & CAUTIONS

- Reconstituted thrombin can be used up to 4 hours after preparation.
- Presence of surrounding consolidation / effusion provide a sonographic window enabling real time guidance for needle placement and thrombin injection.
- Surrounding consolidation / effusion may also provide tamponade effect reducing the risks of bleeding from direct puncture of pseudoaneurysm sac.
- In case there is little surrounding consolidation, it is better to have simultaneous endovascular control as well, to prevent catastrophe in case of rupture of pseudoaneurysm.
- **Slow injection rate** allows thrombin to diffuse throughout the pseudoaneurysm interior promoting thrombosis with smaller volumes and fewer complications.

- Needle tip should be far from the neck of pseudoaneurysm to avoid occlusion of main artery.

- **Wide-necked pseudoaneurysms need to be handled with significant caution**.

- In the absence of sonographic window, CT guidance is used and test injection of contrast or contrast mixed with thrombin can be injected for confirmation.
- ~500-1000 units of thrombin are usually sufficient for treatment
- Spurt / free flow of blood initially serves as an indicator that the needle tip is correctly positioned within the pseudoaneurysm. Later on, cessation of back flow indicates thrombosis.
- Patient may cough or expectorate blood on table, thus one must be ready with oxygen, suction and intubation set
Glue-lipiodol mixture (~50%) is an alternative to thrombin

- Stronger, instantaneous and more permanent occlusion
- May be preferred in case of intracavitary pseudoaneurysms
- Real-time visualization possible under fluoroscopy which is not there while injecting thrombin
- May block the needle
- May incite inflammation, causing bronchial erosion, lung infarction
Potential Complications

- Adverse immunological reactions (in case of bovine thrombin),
- Iatrogenic infection
- Non-target embolization
- Recurrence / recanalization

are the primary concerns while using thrombin/ glue.
The case series demonstrates that percutaneous direct embolization is a safe and effective minimally invasive therapeutic option for pulmonary pseudoaneurysms, especially those surrounded by consolidation.
REFERENCES
