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Case Report

Pulmonary artery stenting in cancer patients: A single-center experience ☆

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ABSTRACT

Endovascular stenting of the pulmonary artery treats arterial stenosis from pulmonary hypertension, congenital heart defects, or post-transplant stricture. Patients with malignant extrinsic pulmonary arterial compression, secondary to large mediastinal or pulmonary masses, often present with dyspnea, hypoxemia, and right ventricular failure. Conventional therapies like surgery, chemotherapy, and radiation are often slow and fail to promptly resolve acute symptoms.

Balloon angioplasty and stenting have been explored as a rapid treatment to alleviate symptoms of external pulmonary artery compression. Despite its potential, the adoption of this procedure is limited due to risks like stent misplacement, migration, cardiac arrhythmias, and arterial rupture.

This paper presents 3 cases of pulmonary angiography and stenting performed for malignant extrinsic pulmonary artery compression. These cases aim to demonstrate the feasibility of pulmonary artery stenting, encouraging its consideration as a palliative option for symptomatic patients with this condition.

Introduction

Endovascular stenting of the pulmonary artery is a relatively well-explored procedure to treat arterial stenosis arising from pulmonary hypertension, congenital heart defects, or post-transplant stricture [1]. Patients with malignant extrinsic pulmonary arterial compression secondary to large mediastinal, hilar, or pulmonary masses often present with similar symptoms, including dyspnea, hypoxemia, and right ventricular failure [2]. Conventional approaches for managing these patients involve surgery, chemotherapy, and radiation therapy to reduce the size of the compressive mass and improve pulmonary arterial flow. However, these malignancies are often incurable and thus the conventional therapies are slow to resolve patients' acute symptomatology—which is often their primary concern and can result in repeat emergency department visits [1].

☆ Competing Interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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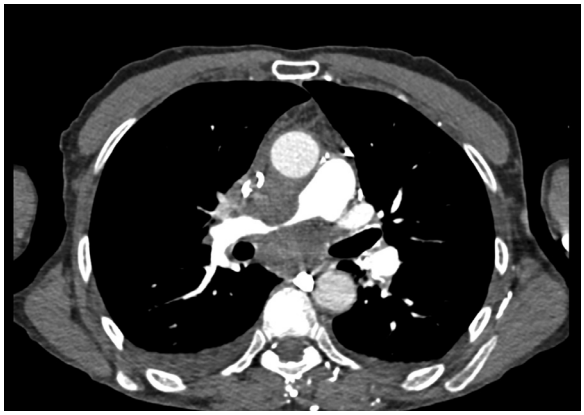

Fig. 1 – CT axial of the mid chest shows severe compression of right main pulmonary artery by mediastinal mass.

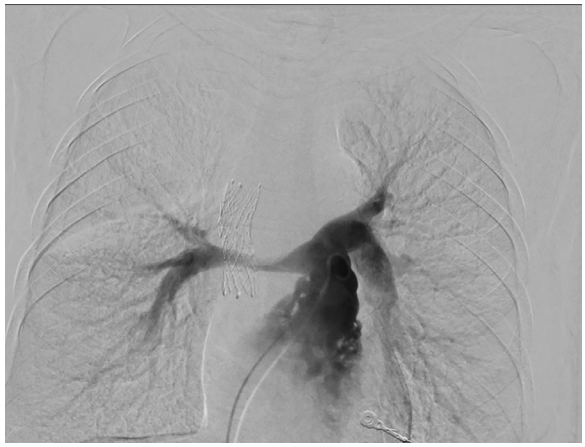

Fig. 2 – Preprocedure pulmonary angiogram demonstrated severe compression of right main pulmonary artery.

Over the past 2 decades, balloon angioplasty and stenting has been explored by interventional radiologists as a rapid and effective treatment to alleviate symptoms of external pulmonary artery compression, for which endovascular therapy is not currently a first-line indication [3]. While stenting does not address the underlying malignancy, it can be a useful adjunct for prompt symptom relief as well as palliation. Despite these benefits, widespread adoption of the procedure remains rare [4].

Pulmonary arterial stenting is not without risk of complications, which can include stent misplacement, stent migration, cardiac arrhythmias, transient pulmonary edema, arterial dissection or rupture, and distal embolization [1]. However, case reports from multiple institutions have suggested that with appropriate patient selection, this minimally invasive therapy can fulfill an unmet care gap by providing patients relief from acute cardiopulmonary symptoms with favorable long-term clinical outcomes [1,5–7]

Given these encouraging examples, we describe herein a series of 3 cases at our institution where pulmonary angiography and stenting was performed to address cardiopulmonary sequelae of malignant extrinsic pulmonary artery compression. We present these cases to contribute to the corpus of literature on endovascular management of these patients, with the goal of invigorating interest and improving confidence of the interventional radiology community in the utility of pulmonary artery stenting for this underserved indication. The Institutional Review Board (IRB) were not required based on the policy for studies involving fewer than 3 patients and the retrospective nature of the study.

Case 1

A 65-year-old female presented to the emergency department with dyspnea and substernal chest pain radiating to her back. Her medical history was significant for chronic obstructive pulmonary disease, cocaine use, and 20 pack-years of tobacco use. After an unremarkable acute coronary syndrome workup, A CT pulmonary angiogram was performed (Fig. 1), showing new nonocclusive filling defects in the subsegmental branches of the left lower lobe consistent with pulmonary emboli. A 5 cm mediastinal mass was noted to be compressing the superior vena cava (SVC) in addition to the right main pulmonary artery, with approximately 60% narrowing of the SVC and extensive collateral venous circulation in the left hemithorax. The patient was admitted for therapeutic anticoagulation and expedited diagnostic workup of the mediastinal mass. She underwent endobronchial ultrasound with transbronchial mass aspiration. Tissue cytology and further contrast-enhanced CT imaging supported a diagnosis of Stage IV, cT4N3M1, TTF-1 positive adenocarcinoma of the lung.

Interventional radiology was consulted for central venography and pulmonary angiography with SVC and right pulmonary artery stent placement, in the setting of symptomatic SVC obstruction and severe compression of the right pulmonary artery. Digital subtraction angiogram determined complete occlusion of the superior vena cava secondary to tumor compression. Post stenting digital subtraction venograms of the left brachiocephalic vein and SVC demonstrated satisfactory position of the stent with free flow of contrast into the right atrium and no residual SVC stenosis. Next, digital subtraction angiogram of the pulmonary arterial system was performed, which demonstrated severe stenosis of the right pulmonary artery secondary to malignant compression (Fig. 2). A 10 × 37 mm Visi-Pro balloon expandable stent (Medtronic, MN, USA) was advanced into the right pulmonary artery and deployed across the stenotic segment. Postdeployment angiogram demonstrated satisfactory position of the stent and resolution of the previously visualized right pulmonary artery stenosis (Fig. 3). The procedure was completed without complications.

After the procedure, the patient was discussed at a multidisciplinary thoracic tumor board. Her overall clinical condition was stable, and she was discharged home with a plan to initiate oncologic therapy in the outpatient setting. One year later, the patient remains stable with patent SVC and right pulmonary artery stents (Fig. 4).

Case 2

A 50-year-old female presented to the emergency department with chest pain, dyspnea, right upper extremity swelling, and

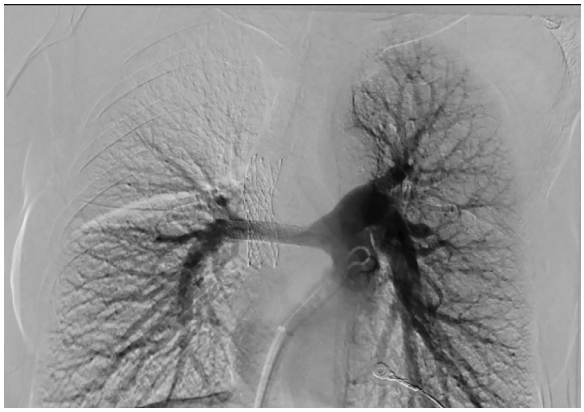

Fig. 3 – Postprocedure pulmonary angiogram demonstrated patent right pulmonary artery with good angiographic outcome.

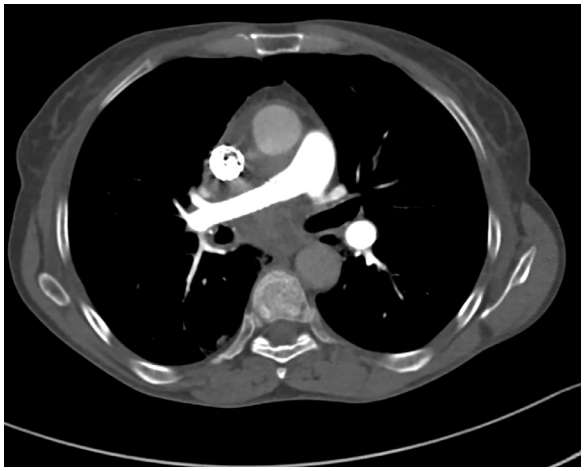

Fig. 4 – Follow up CT chest axial with contrast demonstrated patent right pulmonary artery stent.

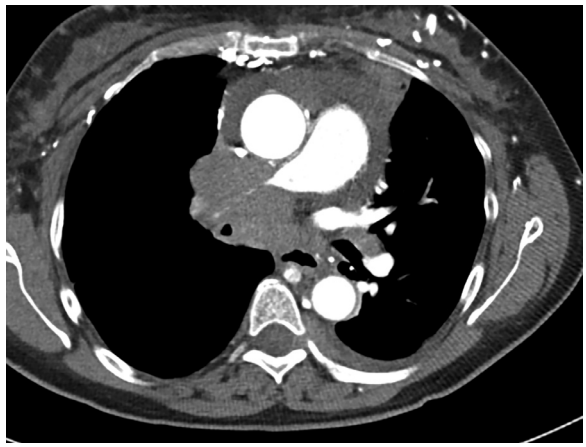

Fig. 5 – CT axial of the mid chest shows near complete occlusion of right main pulmonary artery by mediastinal mass.

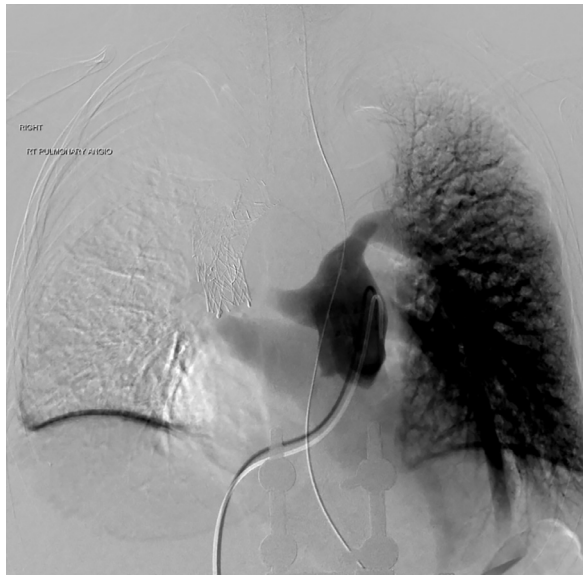

Fig. 6 – Preprocedure pulmonary angiogram demonstrated complete occlusion of right main pulmonary artery.

decreased output of her bilateral nephrostomy tubes. Her past medical history was significant for stage IV cervical cancer treated with radiation, complicated by ureteral strictures, obstructive mediastinal lymphadenopathy, lung nodules suspicious for metastases, and hypertension. A Doppler ultrasound of the right upper extremity was performed due to concern for a deep vein thrombosis and revealed a thrombosis of the mid segment of the brachial vein. A CT pulmonary angiogram was then performed to evaluate for pulmonary embolism. The CT (Fig. 5) revealed no pulmonary emboli but was significant for narrowing of the pulmonary arteries by bulky lymphadenopathy, most severe in the right main pulmonary artery, which was nearly occluded, and left upper lobe pulmonary artery. There was also near complete occlusion of the right upper lobe pulmonary artery.

The patient was discussed at a multidisciplinary thoracic tumor board. Decision was made to proceed with SVC, right bronchial and right pulmonary artery stent in collaboration with interventional pulmonologist. Digital subtraction angiography was performed which showed severe malignant compression with high grade stenosis throughout the SVC. A 20 × 60 mm self-expanding stent was advanced to the SVC just superior to the cavoatrial junction and successfully deployed and postdilated with a 14 × 20 angioplasty balloon.

Next, digital subtraction angiography was performed to evaluate the pulmonary vascular anatomy with redemonstration of pulmonary arterial occlusion (Fig. 6). A 10 × 37 mm VisiPro balloon mounted stent was advanced into the right main pulmonary artery and was deployed across the stenotic segment. Poststenting angiography was performed demonstrating excellent angiographic results (Fig. 7). There were no immediate complications.

The patient's recovery was unremarkable, and her overall clinical condition improved. She was discharged home 5 days following right main pulmonary artery stent placement with

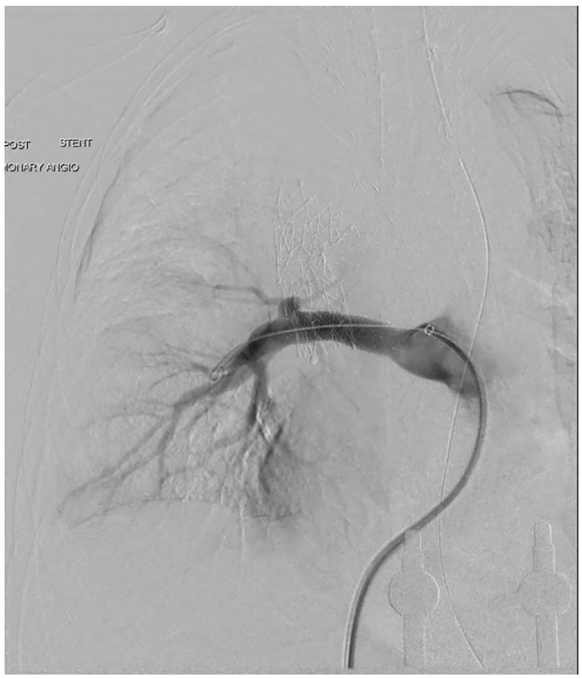

Fig. 7 – Postprocedure pulmonary angiogram demonstrated patent right pulmonary artery with good angiographic outcome.

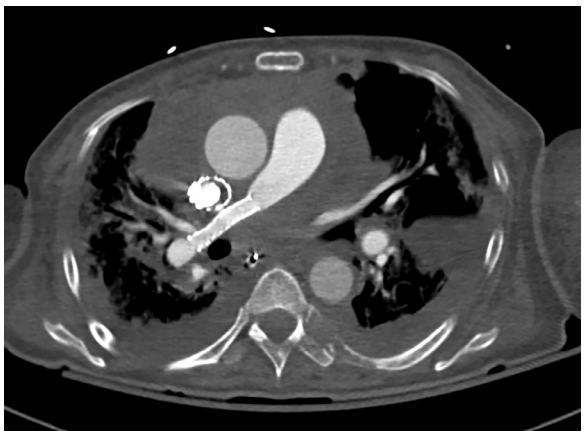

Fig. 8 – Follow up CT chest axial with contrast demonstrated patent right pulmonary artery stent.

plans to initiate outpatient radiation therapy. CT 7 months postplacement confirmed patency of the SVC and right pulmonary artery stents (Fig. 8).

Case 3

A 71-year-old male with past medical history of remote TB with completion of treatment in 1987, COPD, and 50 pack-year tobacco use presented to our institution for elective bronchoscopy to biopsy a suspicious lung mass identified on CT. Patient reported 9 months of progressive dyspnea and new onset hemoptysis. On bronchoscopy, there was a scalloped-appearing mass in the distal trachea adjacent to the carina.

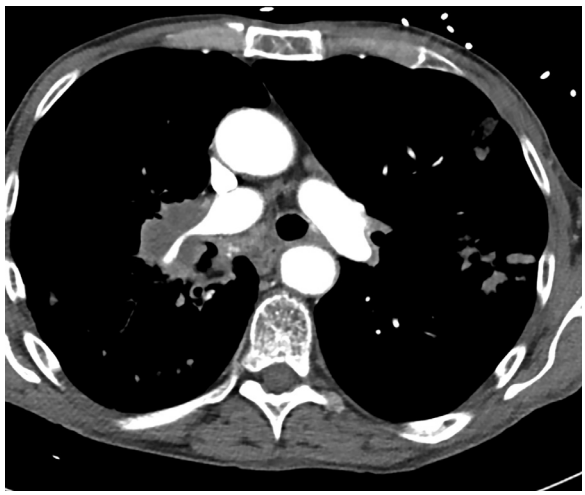

Fig. 9 – CT axial of the mid chest shows moderate narrowing of distal right main pulmonary artery by hilar mass.

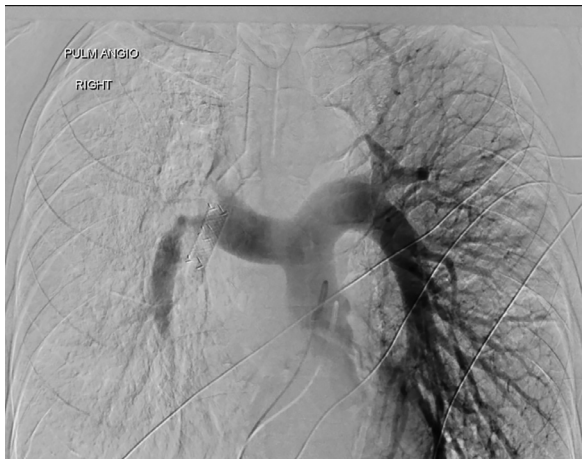

Fig. 10 – Preprocedure pulmonary angiogram demonstrated severe narrowing of right distal pulmonary artery due to external compression.

Beyond the mass was a cavernous space with necrotic irregular mucosa. The patient was admitted for antibiotic therapy and further workup. CT angiography (Fig. 9) revealed a right hilar cavitary mass that communicated with the right main bronchus and right upper and lower lobe bronchial tree. The mass encompassed the right main pulmonary artery with moderate to severe luminal narrowing and occluded multiple right upper and middle lobe segmental pulmonary arteries. A repeat bronchoscopy with biopsy was performed. Tissue pathology of the biopsies revealed squamous cell carcinoma with keratinization along with focal mucicarmine and CK7 positive glandular malignant cells, raising the possibility of adenosquamous carcinoma.

Interventional radiology was consulted for pulmonary artery stenting for malignant compression. Pulmonary angiography (Fig. 10) was performed which demonstrated severe

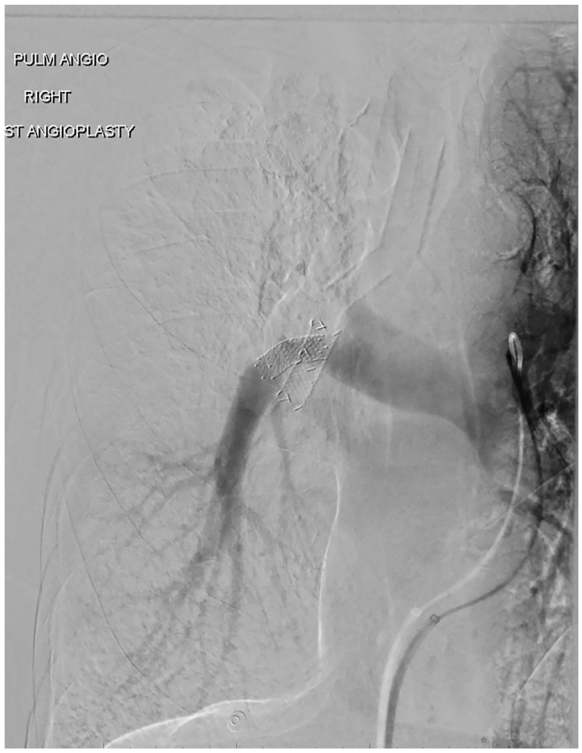

Fig. 11 – Postprocedure pulmonary angiogram demonstrated patent distal right pulmonary artery with good angiographic outcome.

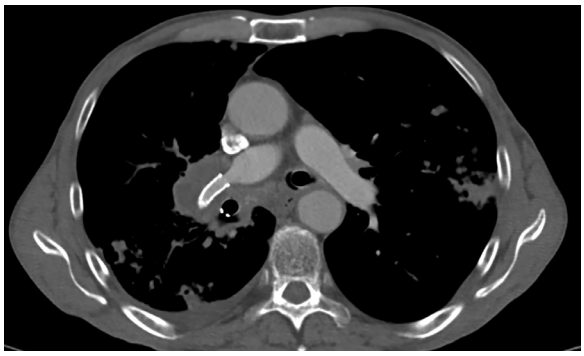

Fig. 12 – Follow up CT chest axial with contrast demonstrated patent distal right pulmonary artery stent.

(greater than 75%) stenosis of the right interlobar pulmonary artery with significantly reduced distal perfusion. A Visi-Pro 9 mm x 27 mm balloon expandable stent was advanced and deployed across the stenotic segment. Subsequent digital subtraction (Fig. 11) angiography was performed which showed significantly improved flow through the previous stenosis. No immediate complications were noted. The patient was discharged with plan for outpatient chemotherapy once his infection resolved. The stent remained patent till last follow up CT 5 months later (Fig. 12).

Discussion

Extrinsic compression of the central pulmonary arteries is a pathology seen in many disease processes, but one that is uncommonly treated via an endovascular approach. While balloon angioplasty and stenting is considered standard of care for other etiologies of pulmonary artery stenosis (such as fibrosing mediastinitis, congenital structural heart defects, and post-transplant stricture), the benefits exhibited have not yet translated into best practices for management of symptomatic compression by bulky neoplastic disease.

This gap likely stems from individual practitioners' limited experience with the procedure and difficulty correlating imaging findings with patient symptomatology. Patients typically present with nonspecific symptoms including fatigue, dyspnea on exertion, and tachycardia. Chronic narrowing in those patients with advanced disease may also result in pulmonary hypertension and right heart failure (cor pulmonale), adding to existing morbidity and mortality in a patient population with already short life expectancy due to their underlying malignancy.

Lack of clear indications for intervention also plays a significant role in the undertreatment of this population. Despite multiple promising case reports written by interventional radiologists over the past 2 decades, the majority of cases are published in cardiology literature and pertain to either congenital heart disease or mediastinal fibrosis. Thus, our purpose in reporting the 3 patient cases described herein is to further demonstrate the feasibility of pulmonary artery stenting as palliative option for symptomatic external pulmonary artery compression in cancer patients. For our 3 patients, all procedures were performed successfully without complications and stents remained patent on last available imaging follow up. In addition to the pulmonary artery stents, 2 patients were treated concomitantly with superior vena cava stents and one with an endobronchial stent that was placed by the pulmonology service. With our contributions, the corpus of literature now shows that pulmonary artery stenting has been successfully applied to treat symptomatic extrinsic compression in patients with non-small cell lung cancer, [1,5] lung adenocarcinoma, squamous cell lung carcinoma [8], lung carcinoid, metastatic malignant melanoma, metastatic cervical cancer, and other unknown mediastinal, hilar, or pulmonary masses [6]. Furthermore, pulmonary artery stents have been placed both unilaterally and bilaterally alongside additional interventions to treat superior vena cava or endobronchial narrowing as well.

Patient eligibility for the procedure is often dependent upon disease status, prognosis, and adequate cross-sectional imaging. Stent selection should be based on vessel diameter and prior reports have detailed the successful use of both self-expanding and balloon expandable stents. More distal stenoses have a greater change in vessel caliber and require more in-depth presurgical planning to ensure an optimal treatment result. Additionally, care should be taken to avoid overdilation of the pulmonary artery, which can lead to transient pulmonary edema by rapid restoration of blood flow across the stenotic segment. Other procedural complications include cardiac arrhythmias, distal embolization,

vascular rupture, dissection, thrombosis, stent migration, and jailing or compromise of other branches. However, these risks are not unique to the setting of patients with malignant extrinsic compression. Postprocedure follow up should include repeat CT imaging to evaluate stent patency and progression of underlying illness, which could lead to worsening external compression by a growing tumor. Pulmonary vasculature has a high concentration of fibrinolytic factors and the risk of neointimal formation with subsequent stenosis is very low, thus anticoagulation is typically limited to heparin and dual antiplatelet therapy is generally not prescribed (unless otherwise indicated). Given the complexity of these patients and their multi-factorial presentations, the authors advocate their discussion in a multidisciplinary tumor board in order to make the best consensus decisions for patient care.

Conclusion

These cases highlight the potential of pulmonary artery stenting as a viable palliative option for patients with malignant extrinsic pulmonary artery compression. Increased awareness and application of this technique can improve symptom management and patient quality of life in this underserved population.

Patient consent

Informed written consent was obtained from the patients.

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