Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 23s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

The Role of Rapid TEVAR in a Complex Ruptured Ascending Aortic Aneurysm

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Cite this paper as: Daud Yudhistira Sukanto, Danang Himawan Limanto, (2025) The Role of Rapid TEVAR in a Complex Ruptured Ascending Aortic Aneurysm. *Journal of Neonatal Surgery*, 14 (23s), 619-624.

ABSTRACT

Background: Thoracic Endovascular Aortic Repair (TEVAR) is a minimally invasive procedure used to manage acute aortic dissection. The timing of intervention is critical, especially in cases requiring rapid response due to life-threatening complications.

Methods: In this case report we collect the patient's data through the mean of interviews, observations, and analysis of patient's medical record.

Results: A female patient in her 60s came to our ER with chief complaint of shortness of breath. Several examinations revealed a ruptured aneurysm in the ascending aorta, accompanied by compression atelectasis in the right middle and lower lobes. Unstable hemodynamics were found throughout the hospitalization period, thus a decision was made to proceed with rapid ventricular pacing TEVAR. The successful deployment of a thoracic stent graft temporarily stabilized the aortic dissection, but the patient's overall condition continued to decline postoperatively. The presence of other significant comorbidities, including possible mycotic aneurysm and metastatic disease, further complicated the management. The patient ultimately passed away on the fourth day of treatment.

Conclusion: This case underscores the critical importance of timely intervention in acute aortic emergencies and highlights the challenges in managing patients with complex and advanced pathologies, even with the use of advanced minimally invasive techniques like TEVAR. The outcome also reflects the limitations of medical intervention in the context of multiple severe comorbidities, emphasizing the need for comprehensive and multidisciplinary approaches in similar cases.

Keywords: *Ruptured Ascending Aortic Aneurysm, mycotic aneurysm, Thoracic Endovascular Aortic Repair (TEVAR), Aortic Dissection, pulmonary mass, metastatic lung disease*

1. INTRODUCTION

Thoracic Endovascular Aortic Repair (TEVAR) has emerged as a minimally invasive approach for the treatment of various aortic pathologies, including acute and chronic aortic dissections, aneurysms, and traumatic injuries. Developed as an alternative to open surgical repair, TEVAR offers the advantage of reduced perioperative morbidity and mortality, especially in high-risk patients who may be unfit for traditional surgery (Nation & Wang, 2015). Open surgical repair, once considered the gold standard for managing these conditions, has gradually been supplanted by TEVAR, which allows for the treatment of complex aortic pathologies through a less invasive approach, often with shorter recovery times (Grabenwoger et al., 2012; Nation & Wang, 2015).

Acute aortic dissection, one of the most critical conditions managed by TEVAR, occurs when the aortic wall tears, creating a false lumen that can disrupt blood flow. This life-threatening condition typically presents with sudden, severe chest or back pain and can lead to mortality due to complications such as aortic rupture, cardiac tamponade, or organ ischemia (Levy et al., 2024). The urgency of aortic dissection requires prompt diagnosis and intervention to prevent fatal outcomes. If not treated immediately, the mortality rate increases significantly, with up to 50% of patients dying within 48 hours of symptom onset (Levy et al., 2024). In cases where there is an impending rupture or compromised organ perfusion, TEVAR provides a rapid and effective solution to address these complications.

Despite the benefits of TEVAR, there remain several gaps in the current understanding of its role in managing aortic pathologies. While studies have demonstrated the effectiveness of TEVAR in reducing complications and improving outcomes for aortic dissection patients, the long-term durability and outcomes of TEVAR compared to traditional open repair are still areas of active investigation. Furthermore, the use of TEVAR in patients with concomitant thoracic pathologies, such as those involving lung masses or metastases, remains less well-studied, and there is limited guidance on how these conditions impact the success of TEVAR procedures.

This case report highlights the successful application of rapid TEVAR in a patient with a ruptured ascending aortic aneurysm, complicated by concomitant thoracic pathologies including a left lung mass and multiple nodules suggestive of metastasis. This case underscores the potential of TEVAR not only in isolated aortic pathologies but also in complex patients with multiple coexisting conditions, offering an alternative to traditional open surgery.

The aim of this case report is to contribute to the growing body of evidence supporting TEVAR as a viable and effective treatment for aortic pathologies, while also identifying areas where further research is needed to optimize its use, particularly in patients with additional thoracic conditions. By exploring the application of TEVAR in such high-risk patients, we hope to provide insights into its broader applicability and improve the understanding of its outcomes in this complex clinical setting.

2. CASE PRESENTATION

The patient is a 65-year-old female presented to the cardio-thoracic-vascular clinic with presenting symptoms of severe shortness of breath. Initial Vital Signs: Blood pressure: 114/82 mmHg, Heart rate: 116 beats per minute, SpO2: 99% on room air During the initial examination when the patient arrived, a chest X-ray revealed opacification in the right hemithorax. As the patient's condition deteriorated, there was an increase in the opacification in the right hemithorax.

A computed tomography (CT) angiogram was performed, revealing a ruptured ascending aortic aneurysm with a contrast-filled hematoma occupying the pleural space, measuring 9.1 x 13.8 x 8.5 cm at the level of T3-T7 on the right side ; Compression atelectasis in the right middle and lower lobes, with surrounding pneumoreaction, suggestive of a possible mycotic aneurysm; Enhancing solid mass measuring 4.2 x 4.2 x 4.3 cm in the apico-posterior segment of the left upper lung lobe; Subpleural nodules in the left pleura and multiple nodules in the left lung, potentially indicative of metastatic processes. Lymphadenopathy in the upper right paratracheal, lower right paratracheal, and prevascular regions. The findings suggested a ruptured ascending aortic aneurysm, possible mycotic aneurysm, and a stage III A lung mass (T2N2M1a according to AJCC TNM 8th Edition) with potential metastatic disease.

Figure 1. Chest X-ray revealed a right hemithorax opacification (left and middle). CT angiogram showed a ruptured ascending aortic aneurysm with contrast-filled hematoma occupying the pleural space.

Given the patient's stable hemodynamics at presentation, close monitoring was initiated. During hospitalization, the patient developed unstable hemodynamics with a blood pressure of 129/80 mmHg, a heart rate of 134 beats per minute, respiratory rate of 28-30 breaths per minute, and SpO2 of 99% with O2 NRM at 10 lpm. Due to the rapid deterioration and unstable hemodynamics, the decision was made to proceed with urgent Thoracic Endovascular Aortic Repair (TEVAR).

Under general anesthesia, the patient underwent TEVAR via a femoral artery approach. During the surgery, it was found a rupture of the ascending aorta 4 cm above the sinotubular junction (STJ) and below the brachiocephalic artery.

The surgical procedure began with insertion of a Temporary Pacemaker (TPM) Lead through a 6 Fr sheath in the left femoral vein directed toward the right ventricle (RV) with the aid of fluoroscopy. TEVAR was performed using a SEAL thoracic stent graft measuring 38 mm x 60 mm. A 28 Fr chest tube was inserted into the right hemithorax.

These interventions were aimed at stabilizing the patient's condition by addressing the ruptured aorta and managing the

complications associated with the procedure.

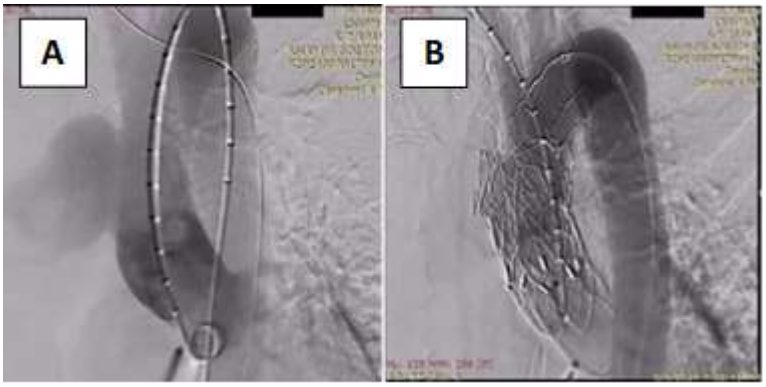

Figure 2. (A) An aortography performed, revealing a rupture of the ascending aorta 4 cm above the sinotubular junction and before the brachiocephalic artery. (B) Aortography evaluation indicated an improvement of rupture

The patient was transferred to the Intensive Care Unit (ICU) for close monitoring. Despite initial stabilization, the patient experienced recurrent desaturation. After extensive discussions with the healthcare team, the family opted for a Do Not Resuscitate (DNR) order. The patient passed away on the fourth day of ICU care.

This case illustrates the challenges of managing complex aortic emergencies in the presence of significant comorbidities, including advanced pulmonary pathology, and underscores the importance of multidisciplinary care in such critical scenarios.

3. DISCUSSION

This case presents a challenging and multifaceted clinical scenario involving a 65-year-old female patient with a ruptured ascending aortic aneurysm, complicating pulmonary findings, and potential metastatic disease. Patients with TAA and chronic dissection usually present with non-specific symptoms. TAA can be suspected in a patients with male gender, older age, prior history of hypertension and chronic obstructive pulmonary disease (COPD), coronary artery disease, smoking habits and previous aortic dissection (Faiza & Sharman, 2023). Even when acute aortic syndromes, chest pain, back pain and signs of malperfusion presented, they often misdiagnosed due to lack of awareness, and most of asymptomatic cases are found incidentally. Chest pain radiating to the back along with severe hypotension should raise a suspicion of dissection, altough chest pain can also occur because of compression of adjacent structures. Some cases also present with difficulty of breathing with signs of superior vena cava (SVC) syndrome and voice hoarseness (due to recurrent laryngeal nerve compression) (Booher & Eagle, 2011; Faiza & Sharman T, 2023). CT angiography could be helpful in deciding the right diagnosis and planning treatment (Grabenwoger et al., 2012). Contrast-enhanced CT scan is the most widely used imaging to aid in diagnosing thoracic aortic aneurysm due to its readily available and rapid assessment of the size, extent, and location of the aneurysm and also the calcification, dissection and mural thrombus of the aneurysm (Elefteriades & Farkas, 2010; Faiza & Sharman T, 2023). Another diagnostic imaging of choice for TAA are MRI which provides an axial and 3D reconstruction of the ascending aorta; transesophageal echocardiography (TEE) which can measure the annulus, sinus, sinotubular junction and ascending aorta dimension; ascending aortography, and PET scans. Chest x-ray examinations may show a convex contour on the right mediastinum, while electrocardiogram (EKG) can reveal some changes associated with aortic insufficiency (Faiza & Sharman T, 2023). However, in this case, the diagnostic assessment revealed an acute, life-threatening situation that required immediate intervention, alongside underlying comorbidities that significantly influenced the treatment approach and outcome.

The decision to proceed with Thoracic Endovascular Aortic Repair (TEVAR) was driven by the patient's rapid hemodynamic deterioration. Patients with acute dissection, rupture, or intramural hematoma is indicated for immediate surgical correction (Faiza & Sharman T, 2023). TEVAR, a minimally invasive procedure, has become the standard of care for managing complex aortic pathologies, especially in patients who may not tolerate open surgery (Grabenwoger et al., 2012; Plichta & Hughes, 2018). TEVAR has been applied to a variety of TAA pathologies including type A dissection, intramural hematoma, penetrating ulcers, aneurysm, and pseudoaneurysm. TEVAR done to manage the ascending aorta (“zone 0” on the Ishimaru anatomical landing zone map) in the settings of emergency surgery for a sick patients who can’t tolerate the risk of open surgery have shown a good outcome and becoma a viable option (Plichta & Hughes, 2018). A recent literature review shown an excellent outcomes in high risk patients, despite of its lacking of standardized technique. The most frequently used device was a throacic stent graft, with TAA dissection becoming the most common indication for surgery followed by ascending aortic pseudoaneurysm (AAP) (Muetterties et al., 2018). However, in our case the procedure was complicated by the detection of a type I endoleak, a common post-TEVAR complication that can compromise the success of the intervention if not promptly addressed (Ganapathi et al., 2014). In the previous study, endoleak type 1 presented in about 18,6% cases, with

9,3% require re-intervention (Muetterties et al., 2018). The subsequent deployment of a larger stent graft and stent molding reflects the need for adaptability and real-time decision-making in managing such high-risk cases. The average all-cause mortality was 15,2% and the aorta-related mortality was 5% with an average follow-up of 17.2 months (Muetterties et al., 2018). Another case series study revealed a lower in hospital mortality with only 13,6% in 22 patients over 8 years (Roselli et al., 2015).

Despite successful stabilization of the aortic rupture, the patient's condition remained precarious, primarily due to the extensive comorbidities identified during the diagnostic workup. The presence of a sizable lung mass with potential metastatic spread (Stage III A, T2N2M1a according to the AJCC TNM 8th Edition) likely contributed to the poor prognosis. The recurrent desaturation episodes in the ICU, despite the correction of the aortic rupture, highlight the severe underlying pulmonary pathology and its impact on the patient's overall condition. Aortic aneurysm are closely related as both are associated with the history of smoking as their risk major risk factor (Kobayashi et al., 2024; Painter et al., 2024). Previous studies have shown the high risk of AA patients of developing lung cancer in the future (Hohneck et al., 2020; Kim et al., 2021). In a study from Kobayashi et al. which included 952 patients, 85 had lung cancer (LC) upon AA diagnosis and 50 developed LC during the follow up periods. Main cause of death in this case were the lung cancer (27.7%) followed by aortic disease (21.1%) (Kobayashi et al., 2024). Aortic aneurysms (AA) are related to high level of systemic inflammation which also play a key role in tumor development. Previous study have shown that pro-inflammatory cells are important in inducin immunosuppression, thus promoting the tumor growth and spread (Singh et al., 2019; Zhao et al., 2021). The importance of the enzyme cytochrome P450 (CYP), which plays a key role in metabolizing various drugs and substances, has been confirmed. In particular, CYP 2A13 was found to be downregulated in lung adenocarcinoma (Li & Xiaoli, 2013; Pasqui et al., 2024). The presence of respiratory diseases resulted in poor outcomes in (AA) patients based on previous studies (De Bruin et al., 2010; Patel et al., 2016; Sweeting et al., 2017).

The outcome of this case, culminating in the patient's death despite aggressive surgical and supportive care, underscores several critical points. First, it highlights the complexity of managing aortic emergencies in patients with significant comorbid conditions, where the interplay between cardiovascular and oncological pathologies can complicate both the treatment and recovery processes (Plichta & Hughes, 2018). Second, it emphasizes the importance of a multidisciplinary approach, involving cardiothoracic surgeons, oncologists, pulmonologists, and critical care specialists, to optimize patient outcomes in such complex cases. Furthermore, patient's decision of opting for Do Not Resuscitate (DNR) order reflects the need for clear communication and shared decision-making between healthcare providers and patients' families. In scenarios where the prognosis is poor, and the potential for recovery is limited, it is crucial to align the treatment approach with the patient's and family's wishes, ensuring that care remains compassionate and patient-centered.

4. CONCLUSION

This case illustrates the formidable challenges in managing acute aortic emergencies in the context of significant comorbidities. The decision to perform rapid Thoracic Endovascular Aortic Repair (TEVAR) was necessitated by the patient's life-threatening aortic rupture and unstable hemodynamics. Despite the technically successful intervention, the presence of advanced pulmonary pathology and potential metastatic disease significantly compromised the patient's overall prognosis. This case underscores the critical importance of a multidisciplinary approach in the treatment of complex cases where cardiovascular emergencies intersect with other severe systemic conditions. Additionally, it highlights the limitations of even advanced interventions like TEVAR when faced with multiple concurrent pathologies, emphasizing the need for comprehensive preoperative assessment and ongoing postoperative vigilance. Ultimately, the outcome of this case reflects the complexities and unpredictable nature of treating patients with severe and multifactorial conditions.

SIGNIFICANCE OF THE STUDY

Ruptured aortic aneurysm still remain as a complex and formidable challenge with significant comorbidities

AUTHOR ONTRIBUTION

DYS and DHL conceptualized and designed the study. DYS performed the data acquisition. DYS conducted the analysis and prepared the manuscript. DHL provided the advice and validation for the final revision. All authors read and gave approval to the final manuscript.

ACKNOWLEDGEMENTS

Not applicable

FUNDING

The authors report no funding

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