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CASE REPORT

A singular use of PEEP during Thermal Ablation of a Lung Lesion Adjacent to the Aorta: A Case Report

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Abstract

Background: Thermal ablation is a minimally invasive procedure commonly performed for treating pulmonary lesions. However, its application near critical structures such as the aorta poses significant challenges, requiring precise anesthetic and procedural management. This report describes the anesthetic and procedural management of a 58-year-old woman with a pulmonary lesion near the aorta, who underwent thermal ablation under one-lung ventilation (OLV).

Methods: The patient, with a prior history of moderately differentiated adenocarcinoma and Takotsubo syndrome, was scheduled for thermal ablation of a 6 mm nodule in the left lower lung lobe. Preoperative evaluation revealed no significant coronary lesions. Under general anesthesia, OLV was established, and the left lung was excluded from ventilation to immobilize the lung. After needle for thermal ablation positioning, the aorta resulted into the thermo ablation area. Critical positive pressure application to the left lung was used to displace the aorta away from the ablation field.

Results: The application of continuous positive airway pressure of 5 cmH_2O was applied to the non-ventilated left lung resulted in an 8.19 mm displacement of the aorta, enabling safe thermal ablation without damaging critical structures. Intraoperatively, the patient remained stable, and postoperatively, she was discharged uneventfully after 3 days.

Conclusions: This case highlights the importance of multidisciplinary collaboration and tailored anesthetic management in high-risk procedures involving pulmonary lesions near critical vascular structures. OLV with selective intubation, combined with careful positive pressure application, played a crucial role in ensuring procedural safety.

Keywords: non-operating room anesthesia, mono pulmonary ventilation, PEEP, thermal ablation.

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Introduction

Thermal ablation is a widely used, minimally invasive treatment for small pulmonary lesions, particularly in cases where due to the patients' severe medical comorbidities, surgery is frequently a high-risk procedure. It offers a less invasive alternative to surgical resection, with reduced recovery time and lower morbidity. However, the particular characteristics of the tissue determine the extent of ablation that can be accomplished. In such cases, continuous blood and airflow next to the target in the lung parenchyma is the most crucial component to take into account, especially when the lesion is located near critical structures, such as the aorta or other major vessels [1,2]. Ensuring patient safety while maintaining procedural efficacy requires meticulous perioperative optimisation, planning and innovative anesthetic strategies which may increase the likelihood of a desirable outcome for the patient [3].

This case report presents the anesthetic management of a 58-year-old female patient undergoing thermal ablation of a pulmonary lesion situated in close proximity to the aorta. The complexity of the procedure was further compounded by the risk of vascular injury due to the lesion's location, necessitating the displacement of the aorta from the ablation field. This was achieved through an innovative application of positive pressure to the non-ventilated lung, which played a critical role in ensuring the safety and success of the ablation.

Case Presentation

A 58-year-old woman, with a 30-year history of smoking and a family history of hepatic neoplasia, presented to the emergency department in September 2023. She reported foul-smelling vaginal discharge, resembling fecaloid material. A gynecological examination revealed an irregular mass on the posterior vaginal wall, approximately 2 cm in diameter. A biopsy performed during colonoscopy confirmed moderately differentiated ulcerated adenocarcinoma. Surgery and radiotherapy were ruled out as first-line therapeutic options. During the first cycle of chemyotherapy, she developed angina, caused by Tako-Tsubo syndrome. During follow-up hospitalization, a contrast-enhanced CT scan identified a new solid nodule, 6 mm in size, in the apical segment of the left lower lobe of the lung. A PET scan confirmed the lesion's malignancy. Following multidisciplinary discussions, thermal ablation was proposed as a feasible treatment, provided the anesthetic evaluation supported the procedure. Due to the proximity of the lesion to the aorta, general anesthesia with one-lung ventilation (OLV) was determined to be the safest approach. Selective left-sided orotracheal intubation was planned to enable exclusion of the left lung from ventilation, thus providing optimal surgical conditions for thermal ablation near the aorta. The patient was prepared for the procedure with continuous monitoring, including non-invasive blood pressure measurements at five-minute intervals, pulse oximetry, continuous ECG, end-tidal CO_2, and bispectral index (BIS) monitoring to assess anesthetic depth. General anesthesia was induced in the post-anesthesia care unit (PACU) with propofol target-controlled infusion (TCI- Schnider effect-site) and remifentanil (Minto model effect-side). Muscle relaxation was achieved rocuronium. Once the patient reached a BIS value of 50, a size 37 double-lumen endotracheal tube was inserted using a GlideScope® video laryngoscope, with placement confirmed via fibroscopy.

The patient was transported from the PACU to the radiology suite, where the thermal ablation would be performed under CT guidance. She was positioned on her right side. Prior to commencing the thermal ablation, the anesthesiologist excluded the left lung from ventilation. Imaging revealed that the lesion, situated in the apical segment of the left lower lobe, was dangerously close to the aorta (**Figure 1**) This proximity posed a significant risk for potential damage to the aorta during ablation. To mitigate this risk, continuous positive airway pressure (CPAP) of 5 cmH_2O was applied to the non-ventilated left lung, causing mild lung expansion and displacing the aorta away from the ablation field by 8.19 mm (**Figure 2**). This displacement more than doubled the safety margin between the aorta and the targeted lesion, significantly reducing the risk of vascular injury.

The radiology team successfully performed the thermal ablation without further complications. The positive pressure applied to the non-ventilated lung proved essential for creating the necessary space between the aorta and the ablation site, ensuring the procedure's safety.

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At the end of the procedure, the tube was removed and the patient monitored in the PACU for two hours before being discharged to the ward. She exhibited stable vital signs and no adverse events. A chest X-ray showed good expansion and ventilation in both lungs, with no evidence of pleural effusion.

FIGURE 1 - CT scan image before applying positive pressure to the non-ventilated left lung.

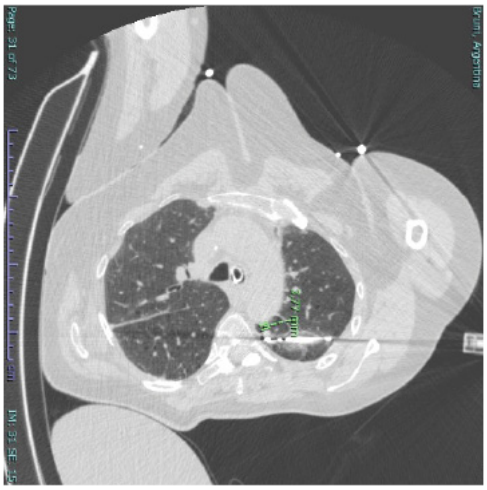
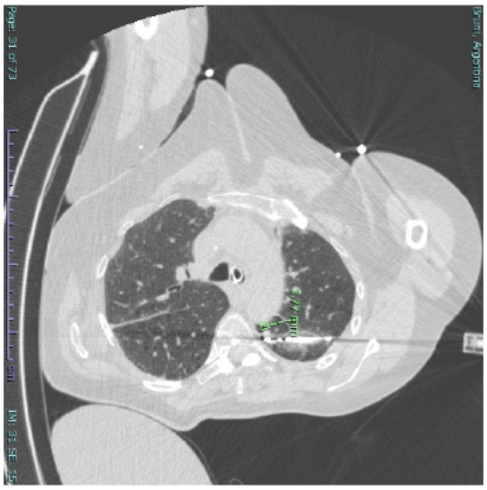


FIGURE 2 - CT scan image after applying positive pressure to the non-ventilated left lung.



Discussion

Image-guided thermal ablation is a reliable and safe technique for managing lung metastases from colorectal cancer. With careful patient selection, this approach can extend survival and reduce the need for chemotherapy. Emerging in the early 2000s, percutaneous thermal ablation offers a minimally invasive alternative to surgery for patients who are either ineligible for surgical intervention or seeking to preserve their quality of life [4]. Numerous studies have demonstrated improved overall survival and progression-free survival following local ablative therapy for carefully selected pulmonary metastases, compared to optimal medical therapy [5].

Thermal ablation of pulmonary lesions located near vital structures, such as the aorta, presents substantial challenges. Effective anesthetic management must ensure both optimal procedural conditions and the utmost patient safety, particularly when the proximity of critical vascular structures increases the risk of inadvertent injury. In this case, the ablation of a lesion located close to the aorta required a highly innovative and flexible approach to maintain procedural safety while achieving complete lesion removal.

The use of one-lung ventilation (OLV), with selective intubation, is a well-established technique in thoracic surgery to isolate a lung for surgical intervention. However, its use in a radiological setting, outside of the traditional operating room, highlights the adaptability and necessity of tailored anesthetic approaches in complex, minimally invasive procedures. The anesthetic strategy employed in this case was particularly innovative due to the critical role of continuous positive airway pressure (CPAP) applied to the non-ventilated lung. This intervention was pivotal in providing a safe margin for the ablation.

The application of CPAP to the non-ventilated left lung was essential not just for procedural facilitation, but for enhancing patient safety. By applying a controlled positive pressure of 5 cmH_2O, the anesthetic team successfully expanded the lung slightly, which resulted in a significant displacement of the aorta from the lesion. This maneuver increased the distance between the aorta and the targeted lesion by 8.19 mm, more than doubling the initial safety margin. Such a displacement was critical in minimizing the risk of thermal damage to the aorta during the ablation process. The use of CPAP and PEEP is also effective in treating hypoxia and atelectasis resulting from one-lung ventilation and they play a crucial role in a protective lung ventilation strategy to mitigate mechanical stress and prevent acute lung injury. CPAP and PEEP are becoming increasingly important when faced with patients who have reduced respiratory reserve and

greater comorbidity, requiring more comprehensive clinical management and additional interventions to prevent perioperative complications [6].

This approach underscores the importance of real-time adaptability in anesthetic management, especially in high-risk cases where the proximity of critical structures makes conventional approaches insufficient. By using CPAP on the excluded lung, the anesthesia team not only facilitated the procedure but also actively altered the anatomical landscape, creating a safer environment for the radiologist to perform the ablation. Without this innovative approach, the risk of inadvertent injury to the aorta would have been significantly higher, potentially leading to catastrophic complications such as vascular rupture or uncontrolled bleeding.

Moreover, the successful use of CPAP in this case provides a valuable precedent for similar high-risk procedures. While OLV is typically employed to prevent lung movement and protect structures, the deliberate and controlled re-expansion of the excluded lung in this case was an essential modification. This intervention appeared to facilitate the careful manipulation of the lesion's relationship to critical vascular structures, potentially making the procedure feasible in a situation that might have otherwise been considered too risky. In this particular case, the application of CPAP to the non-ventilated lung not only displaced the aorta but also provided a stable anatomical shift, enabling the radiology team to proceed with the ablation.

The decision to apply CPAP illustrates a fundamental principle in anesthetic management: maintaining flexibility and control over patient physiology to meet the demands of complex procedures. The collaboration between the anesthesiology and radiology teams was paramount in this case, as the anesthetic strategy directly influenced the procedural success. The real-time adjustments made by the anesthesia team, specifically the use of CPAP to manipulate the proximity of the lesion to the aorta, were integral to ensuring both the safety and efficacy of the thermal ablation. Additionally, this case highlights the broader implications of anesthetic management in non-operating room anesthesia (NORA) settings. NORA procedures have grown significantly over the years, along with the increasing complexity and severity of cases. Administering anesthesia in these often unfamiliar environments carries inherent risks, and complications are not uncommon. Providing anesthesia outside of traditional operating rooms presents unique challenges. However, thorough planning, close communication with the procedural team, the development of clear protocols and support pathways, combined with strong interdisciplinary teamwork, can help ensure safe, efficient, and cost-effective care in the NORA setting [7,8].

The use of CPAP in this case represents a novel application of a conventional technique, demonstrating how NORA settings require a versatile, patient-centered approach to anesthesia.

Conclusion

In conclusion, the application of CPAP to the non-ventilated lung appears to have contributed to making this high-risk procedure more manageable. This case underscores the importance of precise and adaptable anesthetic management in complex procedures involving pulmonary lesions near major vascular structures. By applying positive pressure to the excluded lung, the anesthesia team helped create conditions for the radiology team to perform thermal ablation without compromising the integrity of the aorta. This case emphasizes the value of multidisciplinary collaboration, innovative thinking, and the critical role of anesthetic techniques in high-risk, minimally invasive procedures. While the outcome was successful, further evidence is needed to confirm the broader applicability of this approach.

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