



# Perioperative Desaturation after Onyx (DMSO) Embolization before Surgery

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## ABSTRACT

Onyx consists of an ethylene–vinyl alcohol copolymer dissolved in dimethyl sulfoxide, used in blood vessel embolization. Preoperative embolization of some hypervascular tumors is commonly performed to reduce surgical time and blood loss. However, unwanted effects associated with Onyx can raise perioperative anesthetic concerns. A 19-year-old man, weighing 55 kg with an arteriovenous malformation located in the left popliteal region underwent Onyx embolization 1 day before surgery. Because of observed perioperative desaturation, extubation difficulty, and subsequent respiratory distress, the patient's treatment was continued in the intensive care unit. We present the clinical developments and anesthetic concerns experienced during this study. In patients who have undergone Onyx embolization and exhibit preoperative respiratory distress, tachypnea, and desaturation, postponing surgery, except for emergency indications, may be appropriate. For those undergoing surgery, extubation and subsequent intensive care may be required. Steroids, diuretics, antithrombotic drugs, and antibiotics should be considered in the treatment. Oxygen support with a mask and, if necessary, advanced airway support should be provided.

**Keywords:** Onyx (DMSO), perioperative desaturation, pulmonary edema

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## Introduction

Onyx is a commercially available preparation that consists of an ethylene–vinyl alcohol copolymer dissolved in dimethyl sulfoxide (DMSO). Onyx is used for vascular embolization procedures<sup>[1]</sup> commonly for treating cerebral or spinal arteriovenous malformations (AVMs), highly vascularized tumors, peripheral AVMs, and arteriovenous fistulas. Preoperative embolization of highly vascular tumors is frequently performed with the aim of reducing surgical duration and minimizing blood loss.<sup>[2]</sup> However, it is worth noting that certain complications associated with Onyx may raise concerns regarding perioperative anesthesia.

## Case Report

A 19-year-old man, weighing 55 kg, presented with a long-standing history of pain, visible vein prominence, and edema in the left leg since childhood. Peripheral angiography

indicated the presence of AVMs, which were characterized by three niduses in the midsegment of the left superficial artery, two niduses distal to the popliteal artery, and two niduses at the level of the tibioperoneal trunk. The patient underwent coil and Onyx embolization for congenital AVM in the left lower extremity using two vials of Onyx material. AVM-associated lesions were subsequently excised, with a surgical intervention scheduled for the following day. Unremarkable physical examination findings, normal laboratory values, and a typical Posteroanterior chest X-ray image (PA-CXR) were shown on the preoperative assessment. At the time of evaluation, the patient's vital signs were recorded as follows: blood pressure 120/80 mm Hg, heart rate 110 beats/min, oxygen saturation (SpO<sub>2</sub>) 92%, temperature 36.8°C, and respiratory rate 16 beats/min. The patient had no known underlying medical conditions or history of previous surgical procedures.

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Vascular access was established in the operating theater using a 16G cannula on the right hand dorsal, and an infusion of 0.9% NaCl was initiated. Induction of anesthesia was accomplished with 2.5 mg/kg propofol, 1 µg/kg fentanyl, and 0.6 mg/kg rocuronium, leading to orotracheal intubation. Anesthesia maintenance was established with 2.5% sevoflurane inhalation. After surgery conclusion, the patient was extubated with the aid of sugammadex 150 mg but subsequently experienced bronchospasm and desaturation. Immediate intervention involved intravenous administration of 1 mg/kg methylprednisolone, 45.50 mg pheniramine, and 20 mg furosemide. Despite adequate respiratory effort, peripheral oxygen saturation remained at approximately 93%. The patient was consequently transferred to the postanesthesia intensive care unit with nasal cannula oxygen support for further management.

Postoperative PA-CXR image identified a hyperdense region, with particular prominence in the midsegment. The potential occurrence of pulmonary complications such as pulmonary embolism, pulmonary edema, and acute respiratory distress syndrome (ARDS) arising from the application of Onyx was investigated.

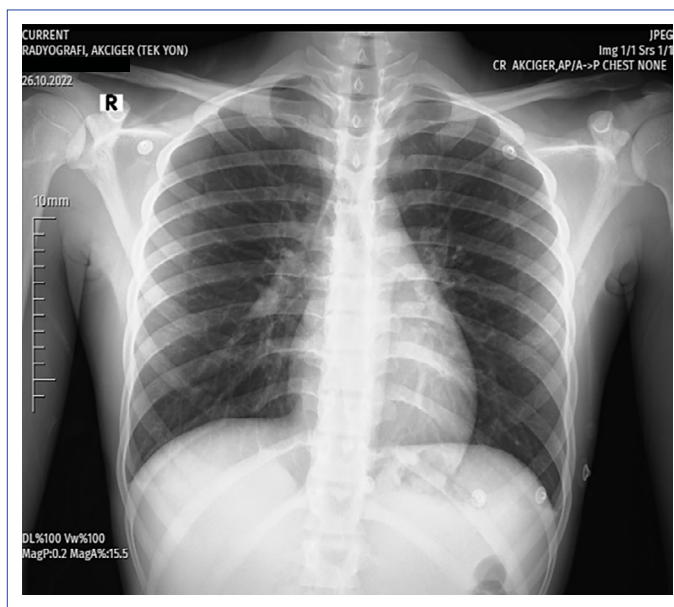
Figures 1–6 show the patient's preoperative and postoperative day 1, 2, 3, 4, and 5 PA-CXR image, respectively.

## Discussion

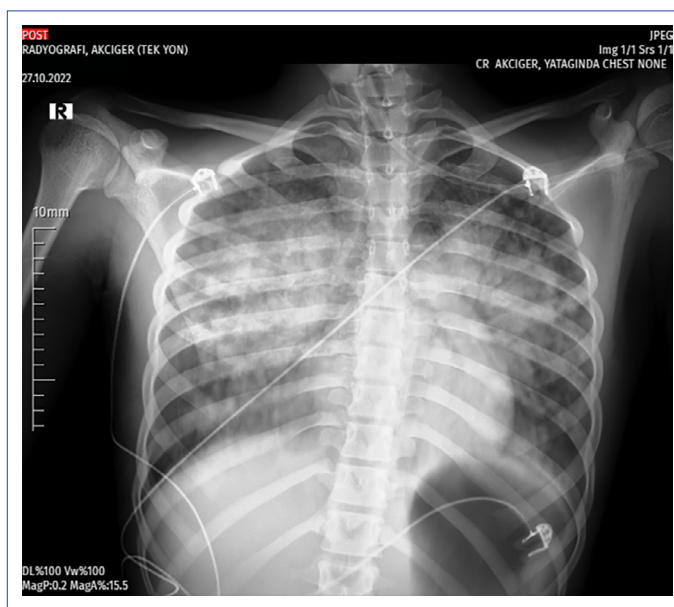
Onyx is a nonadhesive, liquid embolic material with radiopaque properties that is delivered easily via a microcatheter.<sup>[3]</sup> However, one notable drawback of Onyx is its solubility in DMSO. Unwanted effects associated with DMSO, including pulmonary edema, bronchospasm, bradycardia, and even cardiac arrest, have been documented.<sup>[4]</sup>

Asouhidou et al.<sup>[5]</sup> conducted a retrospective investigation of 69 patients who underwent Onyx embolization for AVMs under general anesthesia with no concurrent cardiac, pulmonary, or significant systemic illnesses. Among these patients, 23 experienced intraoperative desaturation, characterized by a decline in SpO<sub>2</sub> by 1%–8% relative to baseline values. Notably, all episodes of desaturation occurred within 3–7 min after DMSO infusion initiation and exhibited duration of approximately 10 minutes, spontaneously reverting to baseline values without the need for clinical intervention. Furthermore, the authors observed no significant hemodynamic perturbations attributable to DMSO infusion. In a patient with extensive AVM, severe desaturation (SpO<sub>2</sub>: 89%, SaO<sub>2</sub>: 8.1 kPa) occurred 10 minutes after extubation, necessitating oxygen support for a duration of 20 minutes before the patient met the criteria for discharge from the postanesthesia care unit.

Tolly et al.<sup>[6]</sup> documented a case involving a healthy 26-year-old man undergoing Onyx embolization for cerebral AVM



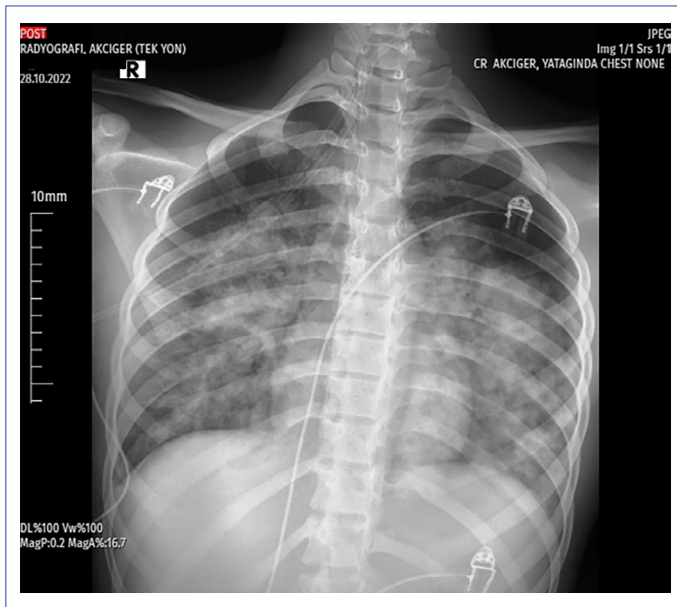
**Figure 1.** The patient's preoperative history.



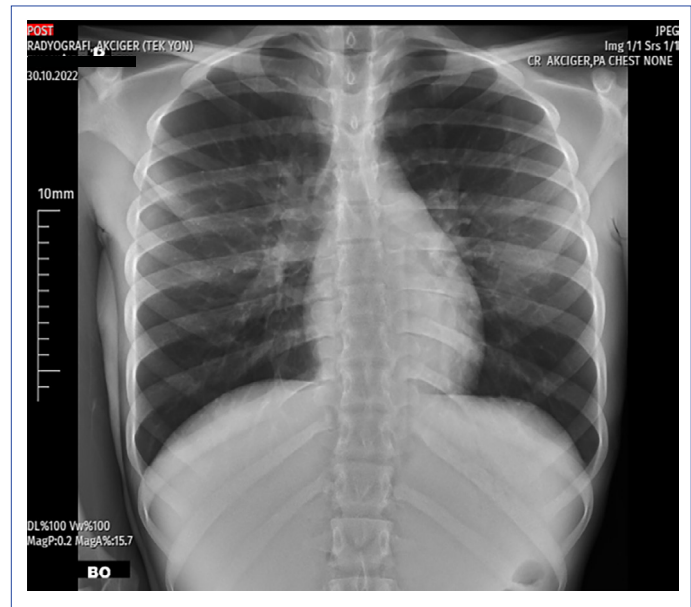
**Figure 2.** Postoperative day 1 PA-CXR image.

PA-CXR: Posteroanterior chest X-ray image.

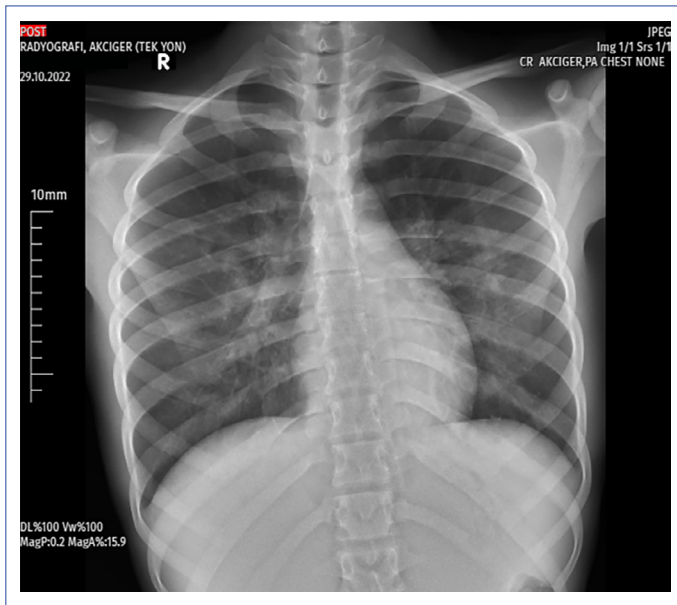
followed by awake craniotomy for resection. Intraoperative events included tachycardia and profound intraoperative hypoxemia requiring substantial oxygen supplementation. Postoperative chest computed tomography showed hyperattenuating Onyx embolization material within the pulmonary vessels, and electrocardiographic changes supported the possibility of clinically significant embolic events. Thus, anesthesiologists must remain cognizant of the potential for pulmonary migration of Onyx material, which can precipitate substantial perioperative hypoxemia. In a case detailed by Tawil et al.,<sup>[7]</sup> a patient who underwent two Onyx embolization procedures for



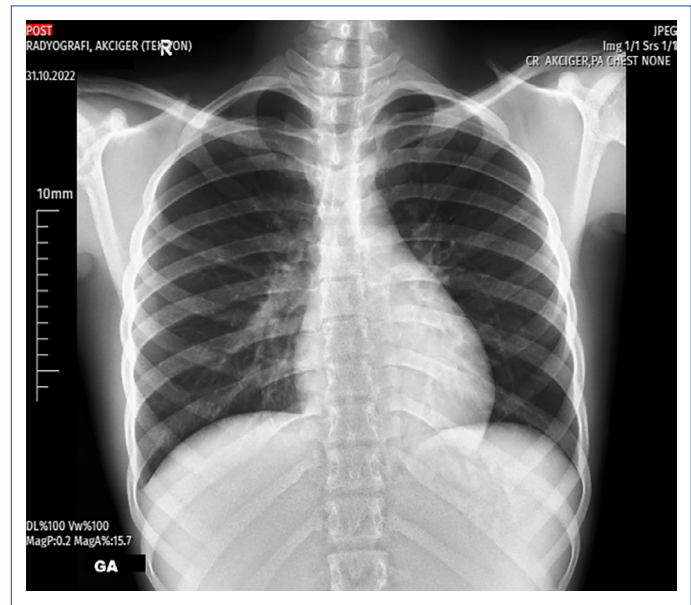
**Figure 3.** Postoperative day 2 PA-CXR.



**Figure 5.** Postoperative day 4 PA-CXR.



**Figure 4.** Postoperative day 3 PA-CXR.



**Figure 6.** Postoperative day 5 PA-CXR.

cerebral AVMs developed respiratory failure secondary to pulmonary edema shortly after the second embolization. Comprehensive evaluation excluded conditions responsible for pulmonary edema, such as heart failure, kidney failure, iatrogenic fluid overload, negative-pressure pulmonary edema, and infectious etiologies. The patient met the clinical and radiographic criteria indicative of ARDS. Murugesan et al.<sup>[8]</sup> reported the occurrence of severe pulmonary edema in a 32-year-old man following Onyx embolization for cerebral AVM. They postulated that ARDS most likely occurred as a result of the pulmonary elimination of DMSO solvent.

In our patient, postoperative laboratory parameters and echocardiographic evaluations yielded unremarkable results. During surgery, 2000 mL of 0.9% NaCl was administered, with a corresponding urine output of 1600 mL. Of note, there was no fluid overload, renal dysfunction, or cardiac insufficiency. The patient's white blood cell count and temperature measurements remained within normal ranges. Bronchospasm occurred during extubation, coupled with challenging positive-pressure ventilation with mask, suggesting negative-pressure pulmonary edema. The quick resolution of symptoms and stability in inflammatory markers strongly suggested a noninfectious

etiology. The severity of clinical manifestations may be attributed to the considerable size of the AVM and the use of two vials of Onyx material. Our patient was categorized as low risk based on the Wells Scoring System for assessing pulmonary embolism risk.<sup>[9]</sup>

## Conclusion

In patients undergoing post-Onyx embolization surgery, perioperative desaturation coupled with respiratory challenges such as dyspnea and diminished peripheral oxygen saturation may be attributable to the development of pulmonary embolism, pulmonary edema, and ARDS associated with DMSO. In patients who have received Onyx, postponing surgery may be a prudent course of action, except in urgent clinical circumstances, if there is evidence of preoperative respiratory distress, tachypnea, and peripheral oxygen desaturation. Adequate measures should be taken to anticipate potential complications and provide timely therapeutic interventions, which may include administering corticosteroids, diuretics, antithrombotic agents, and antibiotics as well as providing oxygen support via mask and, if necessary, advanced airway management during extubation and postoperative care.

## Disclosures

**Informed Consent:** Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

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