

Bronchial Artery Embolization Performed in COVID-19 Patients: Tolerance and Outcomes

Matthias Barral¹  · Marc Sirol² · Mostafa El Hajjam² · Norbert Zhang² · Arthur Petit³ · François H. Cornelis¹

Received: 4 May 2020 / Accepted: 5 August 2020 / Published online: 26 August 2020

© Springer Science+Business Media, LLC, part of Springer Nature and the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) 2020

Dear Editor,

From the 23rd of February 2020, corresponding to the beginning of stage 1 epidemic outbreak in France, to the 5th of May, 25 patients (men: 24/25; 96%) with a mean age of 57 ± 17 years [16–84] had bronchial artery embolization (BAE) for severe hemoptysis (SH). All BAE was performed in a decontaminated positive pressure angiography suite. COVID-19 patients followed a specific pathway including a dedicated intensive care unit (ICU) and elevator. In addition, staff had personal protective equipment including a FFP2 mask, gown, goggles and shoe protection and a face shield [1].

A total of 4 men with 7 BAE had positive COVID-19 RT-PCR (Tables 1, 2), and 3 patients had severe acute

respiratory syndrome (SARS-CoV-2). Subpleural and inferior bilateral ground-glass opacities with crazy-paving suggesting COVID-19 were found in 3 patients with $< 50\%$ of pulmonary involvement in one patient and $> 75\%$ in 2 patients. Bronchial arteries enlargement was seen in 3 patients, and 3 patients had consolidation; no patient had alveolar hemorrhage compared to 17 (17/21; 81%) non-COVID-19 patients ($p = 0.005$, Chi-square test) (Fig. 1). Of all, 71% of BAE was performed under general anesthesia for COVID-19 patients, and none in the non-COVID-19 group ($p < 0.01$, Chi-square test). Microspheres were the most common embolization material, 87% and 71% respectively. Pulmonary shunt was more frequent in COVID-19 (71% vs. 17%, $p < 0.01$, Chi-square test) (Fig. 2).

Embolization of all eutopic and heterotopic bronchial arteries was performed in 86% of COVID-19 patients during the first BAE, and 24-h clinical efficacy was 75% and 100% after a second BAE. Thirty-day mortality was 10% (2/21) in the non-COVID-19 group and 0% in the COVID-19 group. No complication related to BAE was reported. The mean ICU length of stay was superior in COVID-19 patients 23 ± 8 days [13–32] versus 12 ± 14 days [1–46] ($p = 0.007$, Student *t* test).

This case series is the first describing clinical, imaging and outcome of SH and COVID-19 treated with BAE. One patient had bronchiectasis and COVID-19; conversely, the 3 others with SARS-COV-2 had no bronchial or pulmonary condition favoring SH, suggesting the role of COVID-19 in pulmonary parenchyma injury responsible for SH. Of note, all SARS-COV-2 patients had heparin for deep venous thrombosis prophylaxis favoring SH.

✉ Matthias Barral
matthiasbarral@gmail.com

Marc Sirol
marc.sirol@aphp.fr

Mostafa El Hajjam
mostafa.elhajjam@aphp.fr

Norbert Zhang
norbert.zhang@aphp.fr

Arthur Petit
arthur.petit@aphp.fr

François H. Cornelis
francois.cornelis@aphp.fr

¹ Interventional and Oncological Radiology, Hopital Tenon, Assistance Publique des hôpitaux de Paris, Paris, France

² Radiology, Hopital Ambroise Paré, Assistance Publique des Hôpitaux de Paris, Boulogne-Billancourt, France

³ Radiology, Hopital Avicenne, Assistance Publique des Hôpitaux de Paris, Bobigny, France

Table 1 Patients characteristics

	COVID 19 (<i>n</i> = 4)
Age	55 ± 6 [47–63]
Men	4 (4/4; 100%)
BMI (kg m ²)	25.18 ± 5.6 [19–31]
Diabetes	2 (2/4; 50%)
Hypertension	3 (3/4; 75%)
Smoking habit	–
Hemoptysis quantity	250 ± 41 [200–300]
Optic fibroscopy	4 (4/4; 100%)
Etiology of hemoptysis	
Idiopathic	–
Infection	3 (3/4; 75%)
Bronchiectasis	1 (1/4; 25%)
Cancer	–
Tuberculosis	–
Other	–
Days since the beginning of COVID-19 symptoms	21 ± 15 [2–34]
Days since the beginning of stage 1 pandemic	40 ± 16 [18–53]
Enhanced CT	4 (4/4; 100%)
Alveolar hemorrhage	–
Condensation	3 (3/4; 75%)
Dilated bronchial arteries	3 (3/4; 75%)
Pulmonary artery lesion	–
COVID-19 imaging features	3 (3/4; 75%)
Extent of COVID-19 imaging features	
< 10%	–
10–25%	–
25–50%	1 (1/4; 25%)
50–75%	1 (1/4; 25%)
> 75%	1 (1/4; 25%)

Table 2 Results of embolization

	COVID-19 (<i>n</i> = 7)
General anesthesia	5 (5/7; 71%)
Number of bronchial arteries embolized	2.5 ± 0.6 [2–3]
Type of embolic material	
Microspheres	5 (5/7; 71%)
Coils	1 (1/7; 14%)
Onyx	1 (1/7; 14%)
Immediate technical success	6 (6/7; 86%)
Pulmonary shunt	5 (5/7; 71%)
Bronchial–medullary anastomoses	–
Dilated bronchial arteries	6 (6/7; 86%)
Pulmonary artery lesion	–

Characteristics of BAE were similar between groups suggesting the absence of influence of COVID-19 on the catheter or embolic material choice. COVID-19 patients did not demonstrate localized alveolar hemorrhage on CT. However, COVID-19 imaging features and alveolar hemorrhage overlap and may lead to misinterpretation. Consequently, the performance of chest CT to identify and localize the bleeding site may be hampered [2]. Localization of hemoptysis should, thus, solely be based on the results of fibroscopy.

At angiography, COVID-19 patients demonstrated more frequently pulmonary shunts. This may be the result of distal microembolisms in pulmonary arteries [3]. The pulmonary alveolus vascular supply may then be supported by bronchial arteries, favoring an antegrade bronchial–pulmonary shunt [4].

Thanks to a dedicated COVID-19 pathway and strong safety guidelines, no chances were lost for COVID-19 and non-COVID-19 patients, making possible the practice of

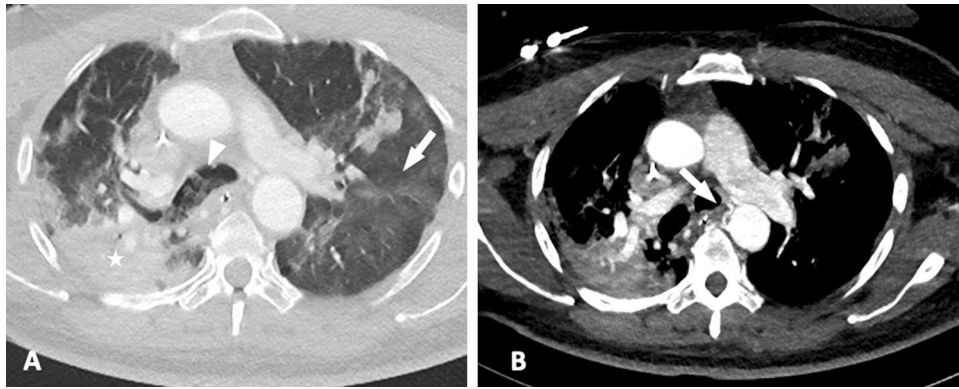


Fig. 1 Contrast-enhanced chest computed tomography at the arterial phase in a 63-year-old patient with severe acute respiratory syndrome due to coronavirus 2019. **A** Chest CT demonstrates goggle-glass opacities with crazy-paving (white arrow), posterior condensation in

the right upper lobe (white star) and a filling of the proximal right bronchus with hemorrhagic material (white arrowhead). **B** Chest CT demonstrates dilated bronchial arteries related to bronchial hypervascularization

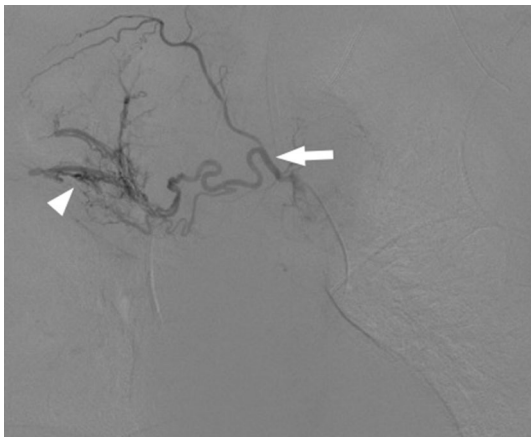


Fig. 2 Digital subtractive angiography of right intercostobronchial artery. Selective catheterization demonstrates dilated bronchial artery with antegrade filling of the right upper lobe pulmonary artery, consistent with a bronchial–pulmonary arterial shunt

emergency interventional radiology (IR). In our study, COVID-19 infection status in the first positive patient was unknown and safety guidelines were neglected. He was possibly responsible for the contamination of two members of the IR staff. Of interest, the conversion of positive to negative pressure room during infectious airborne disease outbreak should be considered to limit the pathogen dispersion to personnel working in adjacent areas [5].

Management of SH in COVID-19 patients with BAE was feasible and efficient. However, respect of safety guidelines is of utmost importance to protect the IR staff.

Funding This study was not supported by any funding.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent For this type of study, formal consent is not required. Informed consent was obtained from all individual participants included in the study.

Consent for Publication Consent for publication was obtained for every individual person's data included in the study.

References

1. Ierardi AM, Wood BJ, Gaudino C, Angileri SA, Jones EC, Hausegger K, et al. How to handle a COVID-19 patient in the angiographic suite. *Cardiovasc Intervent Radiol*. 2020;43(6):820–6.
2. Revel MP, Fournier LS, Hennebicque AS, Cuenod CA, Meyer G, Reynaud P, et al. Can CT replace bronchoscopy in the detection of the site and cause of bleeding in patients with large or massive hemoptysis? *AJR Am J Roentgenol*. 2002;179(5):1217–24.
3. Grillet F, Behr J, Calame P, Aubry S, Delabrousse E. Acute pulmonary embolism associated with COVID-19 pneumonia detected by pulmonary CT angiography. *Radiology*. 2020;296(3):186–8.
4. Khalil A, Fedida B, Parrot A, Haddad S, Fartoukh M, Carette M-F. Severe hemoptysis: from diagnosis to embolization. *Diagn Intervent Imaging*. 2015;96(7–8):775–88.
5. Chow TT, Kwan A, Lin Z, Bai W. Conversion of operating theatre from positive to negative pressure environment. *J Hosp Infect*. 2006;64(4):371–8.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.